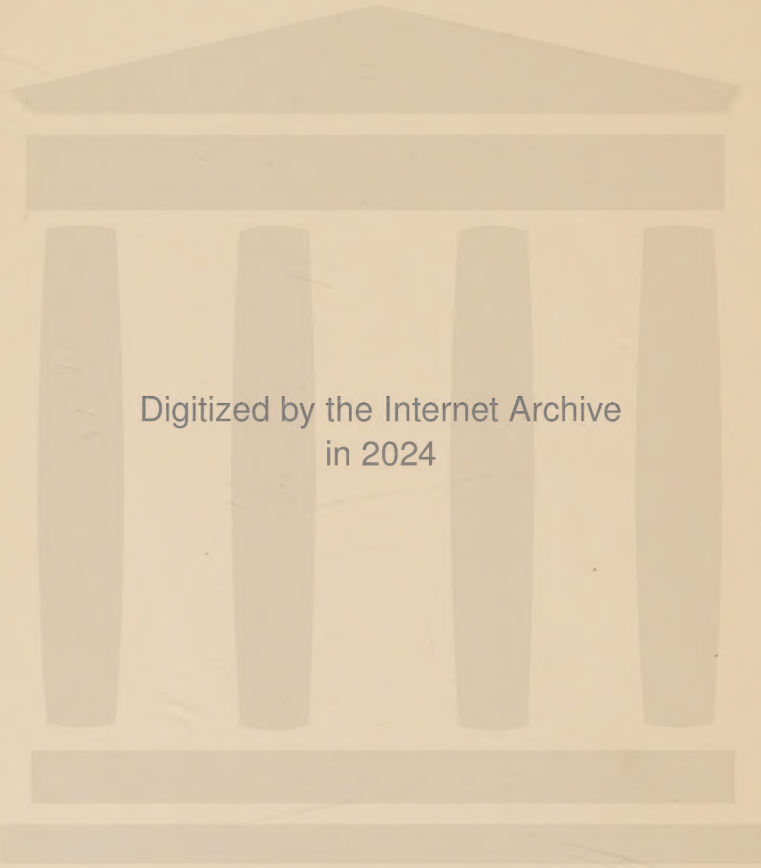


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Fertility and Sterility in Human Marriages

By

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With a section on the

Determining Causes of Male Sterility

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Boston, Massachusetts

Illustrated

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PREFACE

THE recent great advances in our theoretic and practical knowledge of the causes of infertility are scattered through periodical literature. The awakening of general professional interest in the subject which has lately become apparent would therefore suggest that a more comprehensive, though brief, monograph upon this subject might be acceptable to the profession, and since the subject necessarily lies within the fields of two well-recognized specialties some mention of the interrelations between gynecologists and genito-urinary surgeons in the management of these cases is evidently necessary.

The diagnosis and treatment of cases of sterility have long been considered to be within the province of the gynecologist, and even with the increased recognition of the frequency of male sterilities which has appeared within the last few years, that opinion seems to persist. There are, in fact, from the standpoint of practice considerable reasons for this assignment. It is now easily apparent that the diagnosis of the cause of sterility in any given marriage involves an equally careful examination of both partners, and it is evident, on general principles, that the final summing up of all the evidence so obtained into a determination of the cause or

causes of the sterility of their marriage, and of the relative responsibility of each, should be in the hands of one diagnostician. In the case of the man the microscopic examination is of preponderating importance. This can, moreover, be completed in many cases during the very important postcoital examination of the woman, which, of course, demands the technic of the gynecologist. The only other physical examination of the male genital organs which is necessary in a majority of cases is the palpation of the testicles and the prostate, the technic of which is easily acquired. The examination of the genital organs of the woman usually requires, on the other hand, an elaboration of the ordinary gynecologic technic which is not easily acquired by the genitourinary surgeon. For these various reasons those who become experts in the diagnosis of sterile marriages will usually be by training gynecologists rather than genitourinary surgeons.

The expert in sterility should have a knowledge of general practice which qualifies him to make a general physical examination of both patients, and to form a reliable opinion of all the results so obtained in their bearing upon the special problem which is presented to him. If he is not himself qualified to use all the special laboratory methods which characterize modern internal medicine, he should, at least, be able to detect the necessity for the use, in a given case, of one or several of them, and willing to obtain the services of those who are specially qualified on any such point. He should

have a practical familiarity with microscopic work, and will usually be wise if he refers the intra-urethral and other specialized examinations which are necessary in some complicated cases of male infertility to a genito-urinary surgeon who has given special care and thought to this subject. Most gynecologists will prefer to refer all treatment of male infertilities to such a man. The writers of this book have been very fortunate in being able to avail themselves of the wisdom and technical skill of Dr. Edward L. Young, Jr., in the more complicated male infertilities, and believe that the value of the book will be much enhanced by his authorship of the third section.

321 DARTMOUTH STREET, BOSTON, MASS.,

June, 1924.

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SECTION I

BIOLOGY. FREQUENCY OF STERILITY.
PHYSIOLOGY.

CHAPTER I

FERTILITY AND STERILITY AS A BIOLOGIC PROBLEM

No study of fertility can be in any degree satisfactory unless it has been conducted in the light of a competent knowledge of the normal physiology of impregnation. Most of the recent advances in our comprehension of the failures in fertility which constitute sterility are, in fact, the result of work done in the animal laboratories and experiment stations, but it must always be remembered that the anatomy and physiology of any one animal often vary greatly from those of another species. The translation of the results obtained in any one species to the affairs of another is, then, never safe nor worthy of credence until it has been checked up by equally careful observation of the second species. The study of human fertility and sterility in the light of knowledge gained from other animals thus becomes a problem which can be solved satisfactorily only in the light of biologic principles.

In the direct study of any subject in human physiology we necessarily meet many handicaps which do not exist in the laboratory study of the other animals, but we fortunately have, upon the other hand, certain compensatory advantages. We are not ordinarily justified in submitting individuals of the human race to definitely

experimental conditions. We can never adopt a method which is often of the greatest advantage in studying the other animals; we cannot study the physiologic processes in microscopic detail by killing several individuals who are under study in successive stages of an investigation. We are seldom able to provide ourselves with the checking observations which are obtained by the study of control animals. We have, on the other hand, the very great advantage that in the study of the human race we can obtain by cross examination fairly trustworthy accounts of the past history and of the symptoms and sensations. We have also the very great advantages that come from the much more perfect methods of examination which have been elaborated in detail for the human race. The study of human fertility and its failures, therefore, requires an adequate knowledge of general biologic principles, a more detailed knowledge of the physiology of impregnation, and an extended clinical experience, during which the principles of both sciences have been applied to the peculiarities of the human species.

From an early period in geologic time to the present day and from the lowest forms of organic life to its present culmination in *Homo sapiens*, completely developed man, the progress of a species and the survival of individuals has depended upon evolutionary factors which the progress of knowledge in the last half-century have rendered familiar to almost every one.

At a very recent period of geologic time, perhaps not more than twelve to fifteen thousand years ago, a new

factor in evolution made its appearance. Man had then been for a long period physically what he is today; in brain men of the leading races were then probably our equals. In mental power, in capacity for progress they were probably all that we are, but in culture, that is in accumulated knowledge, they were far behind us. They were savages furnished with very imperfect tools, weapons, and appliances. They lived by hunting, surrounded by enemies, and their way of life was very harsh and squalid. At about that period man the hunter gradually developed into man the herdsman. He learned to restrain and guard the animals which he had previously only followed.

The domestication of cattle, then of horses, later, probably, of dogs and many other animals, introduced a new element into their evolution. We do not know at what time he began to supervise their breeding. The histories of the dawn of civilization are concerned almost exclusively with intertribal politics and military exploits. They contain few references to natural laws or matters which are now considered of scientific interest; in point of fact, such things were then unthought of. Since, however, the cattle and horses which were first domesticated are species in which one male commonly rules a troop of females, it is probable that at an early period man learned that many of the males were superfluous and that he might use the less valuable of them for food without decreasing his prosperity as a man of property, as the possessor of a herd. From this to the careful artificial selection which is pursued in the breeding of all

the domestic animals of today is only a matter of degree.

In a wild state the survival of individuals depends upon their toughness and activity, upon their power of resisting the vicissitudes of climate and the seasonal variations in the food supply, upon their ability to elude or resist their natural enemies. In the life of animals under domestication the survival of individuals is not dependent upon these primitive qualities, but upon their possession of the characteristics which are especially valuable to man.

It is only within the last few centuries that man has begun to realize at all the disadvantages and failures which inevitably attend upon overclose artificial selection, as, for instance, to take one point out of many, it is but very recently that we have learned to avoid too close inbreeding. Nothing results so certainly in the preservation of a particular quality as the selection for the breeding-pen of the individuals which possess this quality in the highest degree; but the laws of nature are inexorable, and if this process is persevered in too long without careful selection for vigor and fertility as well, the strain which possesses this quality is too apt to be lost by the appearance of constitutional weakness and sterility, which in the end wipes it out of existence. Of recent years the anxious care of his pocketbook which is characteristic of civilized man has led to much study of animal breeding, and the worst errors of artificial selection are now understood and avoidable, though much remains to be learned.

In the care of his own personal affairs man has been

much less thoughtful. Human matings are governed much more by esthetic and other sentimental considerations than by any desire for the preservation of the best qualities of the race. This prevailing method of selecting our life partners appears at first sight to be unscientific and detrimental, but it is not without its biologic advantages. It produces many physiologically imperfect individuals who are foredoomed to discomfort or suffering, and the worst of such instances might perhaps be avoided by more general knowledge of scientific principles, without serious detriment to the interests of the race. The conditions of civilization and progress are, however, very complicated, and it must never be forgotten that some of the best work in the world has been done by individuals who were the product of marriages which would have been condemned if more advanced eugenic principles had been in vogue.

The processes of natural evolution often involve cruelty to individuals, but their tendency is always in the long run toward the improvement of the species. The great advantage which attends upon the application of a system of indiscriminate matings to any process of selection is well illustrated by the successes of Luther Burbank. His method has been, in essence, the propagation of a great number of individuals by indiscriminate plantings, supplemented by the careful selection from the enormous number of variations so produced, of those individuals which appear to him to be the most valuable for preservation and subsequent fertilization by each other.

Mr. Burbank has worked with vegetables, but the principles involved are equally applicable to all the animals, and to man. Mental and sociologic evolution is still an active process in our species. Indiscriminate matings supply the varieties, and the severe competition of civilized life tends, in the long run, toward the persistence of the most fit. Mental and sociologic evolution is, moreover, dependent upon exceedingly complicated conditions. It is a matter of common observation that except in the worst instances we are quite unable to predict with any accuracy the quality of offspring which will be produced by any given marriage, and from our present knowledge too close an application of eugenic principles would probably be unsafe. Not the least of the disadvantages which would follow upon the application of the methods of artificial selection to the human race, under the guidance of our present very imperfect knowledge, would probably be that in the effort to obtain the qualities which we most desire in our offspring, we should fall into the mistakes which have always characterized our treatment of the domestic animals.

Man is, in fact, the most domesticated of all animals. His ingenuity in the manufacture of houses and clothing enables him to survive in any climate, his utilization of agriculture, and his many methods of preserving and storing food of all kinds renders him, when viewed as a whole, but little liable to loss of numbers from periods of scarcity. He has subdued his natural enemies, and the self-destruction by intertribal warfare which was

formerly constant, and regarded as a necessary incident of daily life, has become at least intermittent. Within the last century he has begun the process of turning his accumulated knowledge toward the modification of natural laws, and the utilization of some of the most stupendous forces of nature for his own advantage. Within the last few decades he has made enormous advances in the prevention of many diseases which of old swept away humanity wholesale. There is every prospect that with a continuance of the advance of preventive medicine health and longevity will reach a standard which our ancestors did not dream of; the advance in this direction has already been great, and it is likely to become much greater. It is only within the last few years that he has become interested in the promotion of his fertility, a subject which is not only of importance to the race, but is perhaps of even greater importance to the happiness of the individual.

The discussion of the subject to which this book is devoted will be arranged in accordance with biologic principles. It begins with a brief consideration of the effects of domestication in man, and in the animals which are dependent upon his care, and will proceed to a similar recapitulation of the physiology of impregnation under the conditions of the highly specialized anatomy of the human race. We shall then be in a position to discuss intelligently the many conditions which produce partial or complete sterility in individual men and women. We shall only then be able to discuss the very interest-

ing subject of the many sterile marriages which are not the result of definite pathologic conditions in either individual, but are sterile matings as a result of a somewhat altered physiology on the part of both individuals.

We shall often be obliged to refer to the results of observations upon other animals, and to use illustrations derived from the study of species other than the human race, but every effort has been made to restrict these allusions to points upon which the laboratory studies have been supplemented by sufficient clinical studies of the human race, made with the advantages, whenever possible, of the exact methods which we can now so often use.

That the medical profession in particular has so long neglected to make any really accurate or profound study of so important a subject is at first surprising. The fact is, that an adequate comprehension of human fertility and sterility was not possible until we were possessed of the general knowledge which has resulted from recent biologic work; moreover, the necessary application of this recently acquired knowledge to the fertility of the human race could only be made through the laborious accumulation of clinical observations by the busy practitioner, who but seldom has the time or energy for such work. The stock of information which has now been obtained is, however, at last so far satisfactory that it may be said with safety, that with careful diagnosis and the judicious selection of treatment which is possible only after such study, a very large proportion of all sterile marriages are susceptible to relief.

It is hoped that the book may be of value to some of those who expect to incur frequently the responsibility of treating sterilities, and to this end it must necessarily be in many sections concerned with technical details, even at the risk of becoming tedious. The general principles of the subject are, upon the other hand, of considerable general interest to the profession at large, and for this reason such chapters will be, as a rule, preceded by a generalized statement, which it is hoped may be sufficient for those who do not care to pursue the subject into its ultimate details.

CHAPTER II

THE FREQUENCY OF STERILE MARRIAGES

THE collection of statistics on this subject is attended by many difficulties.

It would be thought at first sight that some light might be thrown upon it by studies of the domestic animals, in many of which sterility is a matter of much commercial importance, but although sterility due to certain pathologic conditions, and under certain kinds of feeding, has been the subject of extensive study, more especially in cows and fowls, no analysis of its general frequency even in these two species is available. In rats, some strains of which have been studied for many years in the animal laboratories, it has been found that while the mating sterility of certain specialized strains varies from 20 to 35 per cent., that of natural rats of thoroughly mixed parentage and on highly varied diet is slightly less than 10 per cent.

This is of interest for comparison with such information as we possess about the human race.

Statistical attempts to investigate the frequency of sterility in human marriages are rendered difficult and to some extent unsatisfactory not only by the absence of data in official statistics in public health reports, but by the intimate nature of some of the facts involved. An extensive personal search of the literature, supplemented by one made for us by the official efforts of the American

College of Surgeons, has brought to light only about a dozen articles of varying nature. Though the collation of all these results is rendered difficult by the widely varying methods employed, and by the fact that all those which have been used involve considerable inaccuracies, it is interesting to note that the ultimate conclusions reached by all the authors are in close accord.

Simpson, writing about 1850, details the results of observations made for him in two small Scotch villages, where, of 657 marriages, 65, or about 10 per cent., were sterile. He also found that of 495 marriages reported in "Sharp's British Peerage," 81, or about 16 per cent., were sterile, but this latter figure is probably somewhat high, since the methods employed in the collection of the data involved several possible causes of statistical error. He thinks that the existence of at least 10 per cent. of sterile marriages throughout the community would be a safe estimate.

Duncan in 1883 studied the Scotch register of births and marriages. Selecting a series of years in which the number of marriages were closely alike, he thought that the number of births warranted a belief that about 15 per cent. of the marriages were sterile. The inaccuracies of such a method are evident and the result is probably untrustworthy, but his article has been so widely quoted that it is mentioned. He quotes 6 small English studies, with results varying from 8 to 17 per cent., and he, also, finally concludes that 10 per cent. is a fair estimate for Great Britain.

Edis in 1890 says that of 675 marriages analyzed by himself, 10 per cent. were sterile, but does not give any details.

Giles, writing in England in 1919, quotes all these figures and gives the general results of many other studies, including French, German, and one American. He quotes his own gynecologic office records, and sums up with the statement that "It is a sound deduction that the proportion of sterile marriages in this country (England) is well below 15 per cent.," and "that the ratio of sterility varies from about 10 per cent. in the working population to about 16 per cent. among the leisured classes." Taking the numeric preponderance of the working classes into consideration this would again mean a general average of not far above 10 per cent.

Hühner, New York, in 1913 concludes that, after looking over all the authorities, "we may say that, roughly speaking, 10 per cent. of all marriages are sterile."

We can report several personal studies. The questionnaire sent out to their classes by three Harvard class secretaries in preparation for their twenty-fifth year class report shows 478 cases in which all the questions about marriage and children were answered. Of these, 64 marriages, or about 13 per cent., were sterile.

A person of wide acquaintance was asked to mark in a list of city residents every marriage of the results of which she was certain, marking them as productive or sterile. The result was 963 marriages, of which 107 were sterile, or about 12 per cent.

An officer of the Woman's Club of a suburban town in Massachusetts checked the marriages of her acquaintances in the town from the official list of residents in the same way. Result, 195 marriages, of which 25, or about 13 per cent., were sterile.

One of us checked the list of a small metropolitan club in the same way. Result, 103 marriages, of which 12, or about 12 per cent., were sterile.

It will be noticed that these four studies were substantially restricted to the comfortably well-to-do. The combined results give 1739 marriages, of which 208 were sterile, or a little over 12 per cent.

At the time of the second military draft in 1918, which included every man of military age in the community, we employed by permission the chief clerk of the registration board of a large, partly suburban, district to make a statistical search of the blanks filled out in the examination of draftees, with a resulting report that "out of 1000 registrants married on or prior to September 16, 1916 (over two years), 817 had children and 183 (about 18 per cent.) had no children." The district contained some wealthy residents, a large proportion of middle to low incomes, some farmers, and a fair proportion of quarrymen and factory hands. It was, therefore, fairly representative of the community at large.

This inquiry yielded 18 per cent. of sterility out of 1000 marriages, but the method necessarily employed probably involved a considerable error on the high side. In order to obtain 1000 consecutive registrants who

had been married two years or longer it was necessary to study 3250 consecutive questionnaires, the remaining 2250 cases being either unmarried or married less than two years. It is probable that if the inquiry had been limited to those who had been married five years the proportion of sterile marriages would have been much smaller, but this would have involved the search of a very much larger number of questionnaires, and, consequently, the expenditure of a larger amount of time than we were permitted to request.

After careful consideration of the possible errors involved in each of our personal studies we should estimate that the percentage of sterile marriages in Massachusetts is not lower than 10 per cent., and that it is probably as a whole not much higher than 12 to 13 per cent., a close approximation to the final estimates which were made in all the other studies quoted.

It has been manifestly impossible to include in any of these studies an exact or statistical inquiry into the proportion of the sterile marriages which were sterile from voluntary prevention of pregnancy, a subject which is, however, mentioned by several of the authors as having been considered in their final estimate of the probable proportion of true sterility; and upon this point we can obtain no other information than a general estimate of its frequency which has been formed by a number of specially experienced observers.

This inquiry was conducted along two lines. As a result of an impression that the prevention of pregnancy

frequently disturbs pelvic health we have for many years asked all gynecologic patients about their habits as regards prevention. Unfortunately for our present purpose, but for an obvious reason, we have not kept written records of their answers, but the general impressions which we have received are very clear. First, that among the intelligent proportion of the community regulation of the size of the family by artificial prevention is so far general as to be the rule. Second, that the entire prevention of children by such means is very infrequent. We have seen but few married women who did not wish at least for one child, and but few married men who did not wish at least one son to carry on the name.¹

Second, in order to obtain as valuable an opinion on this point as is possible we have submitted this opinion as derived from our own experience to a considerable number of gynecologists of wide experience, and have found them unanimous in their assent to it.

In conclusion and on review of all the evidence obtainable, it is evident that we have as yet no exact knowledge of the frequency of sterility in human marriages, but that there is a general consensus of opinion that an estimate of approximately 10 per cent. of involuntary sterility is the nearest approach to the truth at which we can arrive. It will be noticed too that this estimate is in close accord with that which has been accurately established for the laboratory rats under natural conditions.

¹Prevention of pregnancy during the first one or two years of married life for economic reasons is, however, frequent, and may go far to explain the high percentage of sterility obtained in our investigation of the military draft in 1918.

CHAPTER III

PHYSIOLOGY

THE "MECHANISM OF FERTILITY" AND ITS FAILURES

THE physiology of reproduction is directed only to the maintenance of the species, and is fundamentally distinct from the processes which govern the life of the individual.

Any discussion of it in its entirety would be far beyond the scope of this small book, but the essential point and the end to which all its efforts are directed is the fertilization of an ovum produced by the female, by a spermatozoön produced by the male; and certain parts of the genesis of these two entities, the gametes, and of their passage through the organs of both sexes to their meeting and conjugation, constitute a section of that physiology which may be called the physiology of impregnation, or, when it is normal, the "mechanism of fertility."

The existence of this mechanism in normal form in both partners determines the fertility of the mating. Conversely, sterility in a given mating may be produced by any one of many distant causes; but that cause, whatever it may be, produces sterility only by disturbing the mechanism of fertility at some point in the genital canal of one or the other of the individuals concerned. For this reason a thorough understanding of this mechanism is

essential to any real comprehension of our subject of fertility and sterility in human marriages, and a description of its main outlines when working normally, and of the changes in the genital canals which disturb it, must be given at the onset of this treatise.

It is most readily made comprehensible by following the journey of the spermatozoon from its production in the testicle of the male to its meeting with the ovum in the fallopian tube of the female, and then that of the ovum from the ovary to its attachment in the uterus.

The spermatozoa (Fig. 1) are formed in the testicles as the ova are in the ovaries, and for the purpose of comprehending their journeys through the genital passages they may be fairly conceived as living organisms each of which possesses at least potentially a definite individuality,¹ and lives during its short separate existence an individual life. Each is, in fact, from the time of its detachment from its parent organ and until its conjugation with the other gamete, in independent existence in the fluids of the genital passages. The spermatozoa are endowed with motility and swim steadily forward, while the ovum floats passively in the fluid around it.

The journey of the spermatozoa may be not inaptly



Fig. 1.—Human spermatozoon viewed from the side.

¹ Compare Chapter XVII.

compared to the passage of infant fish through the successive compartments of a hatchery, to which it has many similarities. The baby salmon or troutlings in the hatchery are passed from one compartment to another,

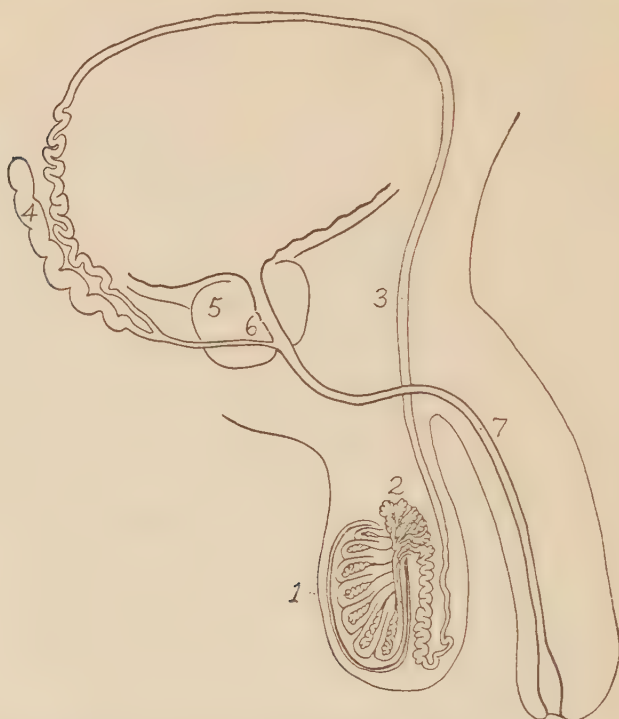


Fig. 2.—The male genital canal, diagrammatic. The canal is shown in its entirety, as it would appear from the median plane if all intervening tissues were cut away. Only one testicle and one seminal vesicle consequently appear: 1, Tubules of the testicle; 2, those of the epididymis; 3, vas deferens; 4, seminal vesicle; 5, prostate; 6, a few of the openings of its tubular glands; 7, urethra.

each of which is supplied with fresh water to insure their health. If at any time the water in any one of the compartments should become seriously contaminated, the fish would be devitalized or destroyed during their pas-

sage through this compartment, even though the rest of the system was in every way perfect.

As the spermatozoa become fully formed in the testicles (Fig. 2) they are floated gently out into the tubules of the epididymis by the scanty serous secretion of the testicles. In these tubules they are stored in enormous numbers to await the moment of ejaculation. They are already endowed with motility, but when undisturbed probably lie nearly still. With the appearance of ejaculation they are suddenly forced with great rapidity through the long, convoluted, and narrow passages of the epididymis and vas deferens. As they enter the urethra the secretion in which they have hitherto existed is changed in amount and character by the secretions which are suddenly poured out by the prostate and seminal vesicles. If any one of the three secretions is harmfully altered in character the spermatozoa must necessarily become enfeebled or die.

On the completion of their passage through the male genitals they are deposited in the vagina (Fig. 3). The vaginal secretion is normally somewhat destructive to their vitality, but a certain proportion of them have the good fortune to be deposited in the neighborhood of the os uteri and are sucked into the cervical canal. Here the character of their journey changes. Throughout the remainder of the female genital canal there is a steady outward current against which they must progress by their own unaided efforts. They are endowed with what we may perhaps term an "instinct" which causes

them to head persistently against a current. Under this influence by steady effort, and often only after several days, some of them may succeed in reaching a fallopian tube, in which under favorable circumstances an ovum may be awaiting impregnation. The first spermatozoön which comes in contact with it forces its beak and head through the outer covering of the ovum, its tail drops off,

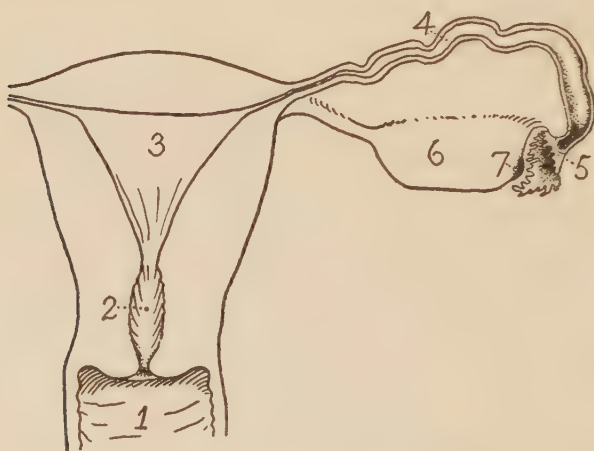


Fig. 3.—The female genital canal: 1, The vagina; 2, the cervical canal; 3, the uterine cavity; 4, one fallopian tube in section; 5, its fimbriated extremity entire; 6, the corresponding ovary; 7, a mature ovum ready for rupture.

and conjugation has been effected. The remainder of the spermatozoa die. If the secretions of the cervix, uterus, or fallopian tubes, or any one of them have become abnormal and unfavorable, all of them which have reached that point must die prematurely, and without having reached the place at which they should meet the ovum.

The journey of the ovum is much shorter. The mature ovum floats in the serous fluid of the graafian

follicle (Fig. 5), until the latter ruptures, when it is washed out by the escaping fluid, and under normal circumstances enters the open mouth of the fallopian tube. In the tube it floats gently downward under the influence of the current until it either meets a spermatozoön or is washed into the uterus, and, if unimpregnated, is usually lost. An impregnated ovum has, however, the power of becoming attached to the uterine wall, by which it is thereafter nourished during its development into the complete child at term. All this is, of course, familiar, but is summarized here for the sake of giving a succinct picture of the process as a whole, because the remainder of the book must be read in the light of these conceptions and because it may be sufficient for the purposes of a reader who only desires a general grasp of the subject.

The more important stages in the development of the gametes and in their journeys toward each other must now be taken up in more detail, since many points in succeeding chapters depend upon some one of these details, and they must be accessible for reference. Further, the various common failures in the mechanism which produce the sterilities will be described here in an anatomic order.

In the human race, as in all the vertebrates, the spermatozoa, which are the essential product of the male, are manufactured in enormous numbers, although only one of them is utilized in the fertilization of the ovum. When the conditions which attend their progress through the genital passages of both sexes are fully understood

the reason for this waste will readily be appreciated. They are formed by cell division of the genetic cells in the testicles, and the process by which each of these cells splits into many spermatids is illustrated in Fig. 4, while the normal morphology of the mature human spermatozoon is shown in Fig. 1. The fully formed spermatozoa are passed from the testicle into the tubules of the



Fig. 4.—Genesis of spermatozoa, diagrammatic: *a*, An early stage; *b*, a later stage; *c*, the spermatozoa are nearly ready for release.

epididymis (Fig. 2), in which and in the ampulla of the vas deferens they remain until the sexual excitation leads to their expulsion through the vas, and into the prostatic urethra, where they mix with the secretions of the seminal vesicles and prostate.¹ The addition of these secretions completes the semen, which is then expelled from the urethra and deposited in the vagina of the woman.

¹ It was formerly taught that the seminal vesicles were utilized as reservoirs in which the spermatozoa await ejaculation, but this is now disbelieved, and the modern physiologic view is that the function of the vesicles is confined to the production of a secretion which is expelled into the urethra during ejaculation.

Fresh semen is alkaline, slightly opaque, somewhat gelatinous, and has a faint though characteristic odor. The number of spermatozoa which it contains has been very variously estimated. It has been placed as low as 2,000,000 and as high as 500,000,000. The amount of semen contained in a given ejaculation varies greatly between individuals and at different times in a given individual. The number of spermatozoa per cubic centimeter also varies considerably in a similar way, and a statement that there are many million spermatozoa in a normal ejaculation is all that need be made. If freshly ejaculated semen is placed at once under the microscope the motion of the spermatozoa is seen to be rather slow and feeble, but after the lapse of a few minutes the previously gelatinous semen undergoes a liquefaction, and when this has occurred the motion becomes much more rapid and active, provided the semen has been kept at or about body heat. The expulsion of the semen completes the male function in the process of impregnation, and for the sake of clearness it may be well to discuss its failures here, and before we proceed to a description of the dangers and losses to which the spermatozoa are exposed in their passage toward the ovum through the female genitalia.

The first of the characteristic failures of the male is to be found in an inactivity of the testicles and a consequent decrease or absence of the spermatozoa.

Inactivity of the testicles may be present in any degree from the total absence of function, which is characteristic

of an atrophied testicle, to the moderate decreases in the number, vitality, and occasionally in the morphology of the spermatozoa, which are not infrequently the result of depressed constitutional conditions.

Entire absence of spermatozoa, *i. e.*, aspermia, may be the result of atrophy of the testicles due to disease, *e. g.*, orchitis during mumps, or of the persistence of an infantile condition from failure of development during puberty, *e. g.*, undescended testicles. It may also exist in spite of the presence of a normal testicle as a result of closure of the epididymis from inflammatory disease, which is usually of gonorrheal origin.

Even in normal semen the number of active spermatozoa is considerably decreased during their progress through the male genital canal. The cause of this loss is unknown,¹ but even when a specimen is placed under the microscope immediately after ejaculation a considerable percentage of its spermatozoa (perhaps from 10 to 15 per cent.) are found inactive, *i. e.*, dead, and this normal loss may be enormously increased by abnormal conditions in any part of the canal, and more especially by abnormal conditions in the vesicles or prostate. Inflammation of the seminal vesicles may produce a secretion which is biochemically poisonous to the spermatozoa, or one which is so sticky and tenacious as to entangle them mechanically and so annul their usefulness. Inflammation and even chronic congestion of the

¹ It may possibly be due to the effects of fluid friction or mechanical violence during their rapid and enforced passage through the tubules and their convolutions.

prostate may also cause either of these conditions, and may thus produce either relative or complete infertility of the male in spite of his possession of excellent testicles and originally highly vital spermatozoa.

The existence of any of these conditions constitutes a failure of the mechanism of fertility and one which is directly referable to the male. Complete or partial infertility of the male probably accounts for fully or nearly half the sterile matings which exist in the community, but the dangers to which the spermatozoa are exposed are by no means terminated by their ejaculation from the male urethra; on the contrary, an enormous majority of those which leave the male alive perish during their contact with the secretions of even the most normal female genitals, and it is especially for this reason that it is necessary to provide them in such enormous numbers in order to permit some one of them to reach the ovum.

The semen with its large percentage of still living and motile spermatozoa is deposited in the vagina (Fig. 3) and at once mixes with the secretion which it contains. The vaginal secretion is normally acid, and even after its admixture with the alkaline semen the vaginal pool, as it is then called, is usually faintly acid. The spermatozoa have existed up to now in an alkaline medium and are not well fitted to withstand acidity. As was said above, they seldom survive for more than one to one and a half hours in a normal vaginal pool, and if the vaginal acidity is high, become still within a few minutes; though, in fact, the acidity is probably only an index to a more complex biochemic hostility.

The great majority of all the spermatozoa which are ejaculated thus perish in the vagina, but a comparatively few specially fortunate individuals (perhaps a few thousand) are so deposited as to survive. Projecting into the vagina is the cervix from which there is always a very slow escape of alkaline secretion which is much increased in quantity at the time of coitus. The cervical secretion is normally quite favorable to the spermatozoa, and those which happen to be deposited in the neighborhood of the cervical opening and within the area covered by this secretion may live when all the others die. Thanks, then, to their power of individual progress and to their habit of heading against a current, some of these may enter the cervix and succeed eventually in reaching the fallopian tube.

The chance of impregnation is, however, probably much favored by another phenomenon. It has been well established by direct experimental observation that in the other mammalia there is during coitus a definite suction into the cervix by which a portion of the semen with its spermatozoa is drawn directly into the cervix with its favorable secretion, or even in some instances into the cavity of the uterus above. These spermatozoa have, of course, not only escaped the hostility of the vagina, in whole or in part, but have a much shortened journey to make by their own efforts, and there is, therefore, a greatly increased chance that some one of them may reach the ovum. Direct experimentation upon this point has not been easily possible in the human race, but there

is much cumulative, though not absolutely conclusive, evidence that a similar suction occurs in the human species. The occurrence of the orgasm, during which this suction probably takes place, is then highly favorable, though not absolutely essential to impregnation.¹

We must now follow the further progress of these few fortunate spermatozoa. They are not infrequently found alive in the cervical secretion as late as three to five days after coitus, but even in a normal cervix the cervical glands secrete a somewhat sticky mucus which mixes with the thinner serous portion of the cervical content, and at the best many of the spermatozoa become caught in this mucus, and, therefore, cease to progress upward, and eventually die entangled. The normal cervical secretion is then chemically favorable, but mechanically somewhat unfavorable, to the existence and progress of the spermatozoa, many of the survivors of which are always destroyed there.

Those which escape entanglement progress upward through the thinner serous portion of the cervical content by their own efforts and enter the cavity of the body of the uterus where there are seldom more than a few (one to five or six) in a low-power microscopic field. The tubes open into the uterus by minute openings, and only a few of the spermatozoa which reach the uterine cavity are likely to find these openings and enter the tube, where they should meet the ovum, but the secretion of the

¹ Some vaginal secretions are more favorable to the spermatozoa than others, and the phenomenon of impregnation without penetration has been known to occur, but is extremely rare.

uterine cavity is thin, serous, alkaline, and in all ways favorable to their life and progress, and if a sufficient number of active and normal spermatozoa have reached the uterine cavity some few of them usually attain the tubes. The secretion of the tubes is highly favorable to the life of the gametes. Spermatozoa are reported to have been found motile in the tube twenty-four hours after coitus, but many cytologists believe that their power of successfully impregnating the ovum lasts a comparatively short time.

The remainder of the physiology of impregnation is dependent on the presence in the tube of a normal ovum at a sufficiently early date after the appearance of the spermatozoön; but before entering upon the somewhat separate subject of the genesis and release of the ovum, it may be well to describe the failures in the mechanism which may occur as the result of changes in the vagina and cervix.

It will be remembered that the vaginal content is normally biochemically hostile, and that impregnation is probably habitually effected by that part of the semen which enters into the cervix, but even this portion is always more or less mixed with vaginal secretion and its cells, as is easily seen under the microscope.¹ When an

¹ The increase of uterine secretion of which we habitually speak as the post-coital flow is probably a physiologic provision for washing from the cervical canal the vaginal cells (and bacteria) which are drawn into it during the orgasm. It is easily seen and appreciated during postcoital examination. It should be just enough to make a current which is sufficiently rapid to carry out the inert bacteria and vaginal cells from which the cervical cavity is normally free, while not so fast that the actively swimming spermatozoa cannot make head against it.

extreme degree of vaginal acidity is present, as is the case in many sterile women, the increased hostility of the secretion may be sufficient to kill even the spermatozoa which enter this admixture. A lesser degree of increased hostility may leave them alive, but may apparently so far decrease their vitality as to render them unlikely to survive the remainder of their journey. Further, for some reason not yet fully understood, but which will be discussed later, this increased vaginal hostility is usually accompanied by ovarian disturbances, but cases are occasionally seen in which the vaginal hostility appears to be the only obstacle to impregnation, as shown by the occurrence of impregnation after satisfactory disinfection of the vagina or after inoculations by autogenous vaccines derived from the individual vaginal content.

The degree of vaginal hostility is suggested by the degree of acidity present, and is more fully demonstrated by the rapidity with which the spermatozoa die in the vagina. It should always be noted and weighed as an element in the case.

It will be remembered again that while the cervical secretions always contain a moderate amount of mucus in which a certain proportion of the spermatozoa become entangled, a reasonable proportion of them normally escape the mucus and pass upward to the uterus; also that the cervical secretion is normally bacteria free, alkaline, and favorable to the spermatozoa, but in the presence of any one of many abnormal conditions the amount of cervical mucus may be increased and its com-

position so altered that all, or almost all, of them become entangled in the mucus while in the cervix. Though they may then continue in motion, they make no further progress, but in the end die from exhaustion while still entangled. When these conditions are present in extreme degree, and especially when they have been long continued, and the leukocytosis of the secretion is extreme, a biochemic hostility usually makes its appearance and the spermatozoa are then poisoned and killed.

Cervical hostility may then be either mechanical or biochemic. It is one of the most common of all the failures of the mechanism of fertility. It is a very frequent complication of other failures, but is not infrequently seen alone, usually as the result of conditions which interfere with free drainage of the cervical and uterine secretions. As has been said above, if the spermatozoa succeed in passing the cervix, some few of them usually reach the tube, and one of them may then effect conjugation with the ovum.

Some one of these failures of normality, or of those which are to be described next, must be present in every case of female sterility.

THE JOURNEY OF THE OVUM

The remainder of the mechanism of fertility which is now to be described is concerned with the formation of the ovum in the ovary, its release, its passage downward to meet the spermatozoa, its fertilization by the spermatozoa, and finally its attachment to the uterus

from which the growing fetus is to receive its nourishment. Since a number of points in this process which are often passed over as unessential are of especial importance in the argument which follows it may be well to precede it by a résumé of the physiology, even though it may seem elementary.

The process of ovulation—*i. e.*, of the formation of mature ova and their discharge ready for fertilization—is essentially similar throughout the mammalia, but varies in some details in the different species in accordance with the varying anatomy of their organs and with the number of young which are produced at a birth.

In all animals the ovaries contain at birth an enormous number of specialized cells which are potential ova, and in many of the lower animals, as, for instance, in fishes, all or most of them eventually develop into eggs,¹ but with few exceptions succumb to the dangers of their environment either before or after fertilization. In the mammalia, on the other hand, where all fertilized ova are protected within the mother's uterus, only a small proportion of the potential ova ever mature. In point of fact, comparatively few of the specialized cells, or primordial ova, even begin development, and the great majority of these become atretic, *i. e.*, cease developing, and are absorbed while still small and contained in a partially developed follicle (Fig. 5). Thus even in

¹ The eggs of the oviparous species differ from the ova of the mammalia only in that in the eggs of the lower vertebrates the ovum contains a larger amount of yolk, and is surrounded by the so-called white, from both of which the embryos derive their nourishment until they break the shell.

the mammalia there is a great waste of the female elements, though while they are in a less fully developed state than is the case in the male. In the pluriparous animals several ova—in the sow, for instance, as many as eight or ten or, more—and their follicles become fully developed and reach the surface simultaneously. In the uniparous animals, on the other hand, as in women, only one completely developed follicle is normally present at any one time,¹ and this is important to remember. It is stated

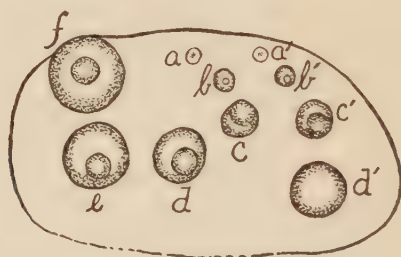


Fig. 5.—Genesis of ova: *a*, *b*, *c*, etc., represent, very diagrammatically, stages in the formation of a mature follicle with its ovum, *f*, the mature follicle; *a'*, *b'*, *c'*, etc., the same earlier stages followed by *d'*, an atretic follicle, in which the ovum has failed and become absorbed.

that the ovary of the female infant may even contain at birth many actual ova (already developed from the primordial cells), but that all such ova degenerate and are absorbed before puberty. During childhood the ovaries remain quiescent, but with the appearance of puberty they take on activity and individual ova begin development in considerable numbers. From this time until the cessation of ovarian activity at the change of

¹ Note the exception that some twin pregnancies are preceded by the development of two ova simultaneously.

life ova in all stages of development are continuously present in a normal ovary.

Each developing ovum is at first surrounded by a layer of cells which are to form the future follicle. As development progresses the follicle is at first filled with a mass of cells derived from this original layer, but quite early in the process of the development of the follicle the so-called liquor folliculi appears among these cells. Throughout the greater part of its development the ovum is attached to one side of the follicle by the cells which surround it, but in the final stage it becomes detached and floats in the liquor. Most of these developing ova, however, undergo atresia, *i. e.*, degenerate, at one or another stage of their development and before they become mature.

As development progresses the ova move deeper into the ovarian tissue, but during the later stages of development again move outward, and the mature ovum finally protrudes partially from the surface. The wall of the protruding portion of the follicle then thins and finally ruptures, when the ovum is washed out with the escaping liquid and is received by the fallopian tube. The mucous membrane of the fallopian tube is furnished with ciliary cells which move their cilia continuously to and fro like oars and create a current downward in the serous secretion of the tube. This current is believed to favor the entrance of the mature ovum into the tube and to propel it onward through the tube. The current is, of course, very gentle, probably hardly perceptible, and

although it is sufficient to float the ovum onward, the spermatozoa are able to progress against it. When a spermatozoön comes in contact with the ovum, it immediately penetrates into its substance, when the tail disappears, but the rest persists as the male pronucleus ready to unite with the female pronucleus, which is the essential and active portion of the ovum. This union of the spermatozoön and ovum completes the process of fertilization.

The processes of cell division and multiplication (which are initiated by the chromatin content of the fertilized ovum), and the formation and subsequent history of the chromosomes and their derivatives, which govern the further development of the embryo, form one of the most interesting chapters in the physiology of reproduction, but they are beyond the purpose of this chapter and will not be further referred to here.¹

The fertilized ovum passes slowly onward under the influence of the fallopian current and is discharged into the uterus. Here it is believed to dissolve for itself a hollow in the mucous membrane of that portion of the uterus against which it comes to rest. The cells of the mucous membrane in its immediate neighborhood then undergo a rapid development by which they surround (Fig. 6) and eventually enclose the developing ovum, thus forming the maternal decidua. The further development of the ovum constitutes the process of normal pregnancy.

¹ Compare Chapter XVII.

One further process which has been as yet omitted for the sake of clearness, but which is an essential element in the mechanism of fertility, must now be summarized from the point of view of sterility.

After the discharge of the ovum and of the liquor folliculi the ruptured follicle closes and undergoes a series of changes which result in the formation of the interesting structure which is known as the corpus luteum. The fully formed corpus luteum consists of large cells of bright yellow color, which are known as the luteal cells, surrounding a central mass of connective tissue, which also extends by fine filaments between the luteal cells and into the ovarian stroma around it. This connective tissue contains numerous blood-vessels, so that the corpus luteum in its final stage is highly vascular.

The exact method by which the luteal cells originate and much of the cellular part of their subsequent history are still the subject of controversy and have given rise to an enormous literature. These histologic points are, fortunately, not of direct concern to our purpose, and no attempt will be made here to even summarize this literature, but the function of the corpus luteum as a



Fig. 6.—Diagrammatic; an early stage in the nidation of the ovum. (For the sake of simplicity the unessential details of the newer theories are neglected in this illustration.)

whole, its subsequent history, and its abnormalities are of much importance, and must now be reviewed.

The fully formed corpus luteum (Fig. 8, p. 57) is about the size of a cherry. If the ovum which has been discharged does not become fertilized the corpus is known as the corpus luteum of menstruation. It then persists in mature form but a few days, after which it degenerates, decreases rapidly in size, and disappears in a few weeks; it loses all functional activity in the first weeks of the catamenial interval and has become little more than a mere cicatrix before the appearance of the next menstruation. If, on the other hand, the ovum meets a spermatozoön and is fertilized, the corpus not only persists, but enlarges, until in the human ovary it may reach the size of a walnut. It is now known as the corpus luteum of pregnancy, and persists until after the birth of the child.

The function of the corpus luteum was long a matter of controversy, and in some details is still a subject on which conflicting views are maintained, but the main facts have become undoubted. It is now believed that it acts as a gland of internal secretion, that it governs the reception of the fertilized ovum by the mucous membrane of the uterus (the maternal portion of its nidation), and that it prevents the occurrence of further ovulation throughout the period during which it is in full activity. Its presence is, therefore, essential to the process of nidation. It will be seen later in this chapter that its abnormalities are of causative importance in certain cases of sterility.

The failures of that part of the mechanism of fertility which are concerned with the genesis of the ovum, its descent, fertilization, and nidation, must now be considered.

The ovaries may under certain conditions fail to produce or release the ova, and such a woman is, of course, completely sterile so long as this condition of non-ovulation persists.

We shall not here discuss the functional inactivities of the ovaries which characterize infancy, the persistence of infantile conditions from arrest of development, or old age, but shall limit ourselves in this chapter to a consideration of the ovarian conditions which inhibit ovulation in mature and previously active ovaries. Such non-ovulating ovaries are seen under two forms. In some cases the ovum degenerates and disappears (*i. e.*, undergoes atresia) after the follicle is near maturity and at, or even when projecting from, the surface. The follicle then fails to rupture and often tends to persist for a long time. On inspection of such ovaries several or many such persistent follicles are seen, and the follicular cysts so created are often considerably larger than the ordinary mature follicle. When they protrude from the surface the ovary may even approach in appearance that of a pluriparous mammal. A distinguishing characteristic of such ovaries is their alteration in shape and tension. The normal ovary is a rather soft, elastic, and flattened organ (Fig. 7), while the ovary which contains persistent follicles is swollen, rounded, and tense.

If this condition persists long enough the connective tissue of the surface of the ovary is likely to become so dense and thickened as to make the rupture of succeeding follicles difficult or impossible.

Even in this stage such ovaries tend to return to the normal and to develop and release the ova normally if the retained follicles are emptied or removed and the

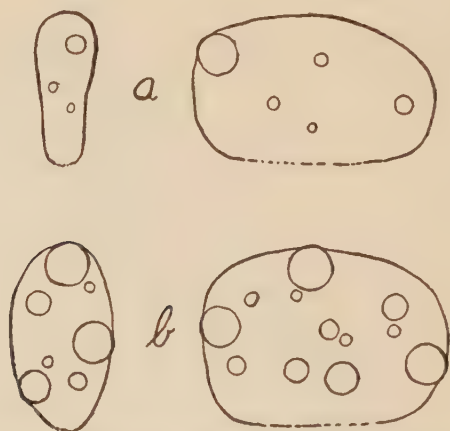


Fig. 7.—Diagram to illustrate the altered shape of a non-ovulating ovary with persistent follicles: *a*, The normal ovary as seen in cross- and longitudinal section; *b*, an ovary with many persistent follicles seen in cross- and longitudinal section.

tension on the ovary relaxed, by operation, in connection with the removal of the causes which originated this condition.

In another class of ovarian infertility the ovaries contain abnormally persistent corpora (Fig. 8). In some such cases the ovary is enlarged by a single corpus, in which the yellow luteal layer is plainly apparent, even though it has become cystic by the degeneration and

disappearance of the central plug and its replacement by fluid, as often occurs in long persistent cases. In other cases inspection of the ovaries shows the presence of numerous persistent corpora in differing stages of slow absorption, the more recent showing the luteal cells, while the others exhibit differing stages of their gradual disappearance. Even if in such cases only one ovary is affected, the other is always in a quiescent and non-ovulating state. It will be remembered that ovulation is habitually absent during the persistence of a corpus in either ovary.

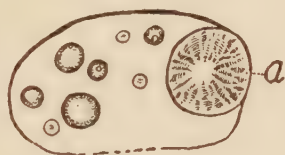


Fig. 3.—A persistent corpus luteum, diagrammatic: *a*, The corpus. During its persistence all follicular development terminates in atresia.

In cases of persistent corpora lutea menstruation is usually somewhat decreased, and, without entering into other phases of the complicated physiologic question of the probable influence of abnormal persistence of function on the part of the corpus, it may be stated that such cases are always sterile so long as the persistent corpus or corpora are allowed to remain in the ovary, but that relief of the distention of the ovary by an operative removal of the corpora and of the *underlying causes* which have produced this abnormality is almost always followed by a return of normal function in the ovaries, and the appearance of pregnancy may then be looked for.

Again, even though the ovaries produce and release normal ova, fertilization fails unless the ovum progresses onward into the tube.

The tubes open directly into the peritoneal cavity, which is the only instance in the mammalian body in which a mucous membrane is in direct continuity with a serous cavity, and it is characteristic of the tubes that at the appearance of the slightest inflammation in their mucous membranes their fimbriated ends become closed by localized peritoneal adhesions, thus protecting the individual from a generalized peritonitis. This closure, of course, absolutely prevents the entrance of the ovum into the tubes and constitutes an absolute sterility, which is discussed at length in an ensuing chapter.

Again, even though the ovum enters a normal tube and meets the spermatozoön, there are still several possible failures in the mechanism of fertility which, for completeness, must be at least mentioned here.

The fertilized ovum may fail to undergo normal segmentation and, consequently, die *in utero*. Again, failure of nidation may result from abnormal conditions in the mucous membrane of the uterus or from failure of the fertilized ovum to perform its part in the attachment, but these several failures in the ovum after fertilization has occurred constitute the causes of miscarriage, and, as the importance of this subject warrants its full discussion in a later chapter, they will receive no further mention here.

SECTION II

THE DETERMINING CAUSES OF
STERILITY IN THE FEMALE

CHAPTER IV

CHRONIC PASSIVE CONGESTION OF THE PELVIC ORGANS

OUR first section culminated in a chapter which described the mechanism of fertility and the altered physiologic conditions which may interrupt this mechanism, and convert it into what might be called a mechanism of sterility. One or more such changes in the mechanism of fertility are always present in one or the other partner to a sterile mating, and they furnish the means by which the successful conjugation of the spermatozoön and ovum is prevented and by which the sterility is established; but for a satisfactory comprehension of any case we must go a step further, we must study the causes which produce these changes in the mechanism.

Since any change in the mechanism of fertility which is producing the sterility in the given mating is itself merely the result of an underlying cause, the only logical and successful method of treatment is to discover and remove the cause (or causes) which have produced that change in mechanism in the individual case. To give an example, a chronic congestion which alters the nutrition of the mucous membranes and so produces abnormal secretions which wash away or otherwise destroy the spermatozoa may be produced in the female by local

lesions such as displacements, lacerations, or new growths. It may, on the other hand, appear in wholly normal organs as the result of unwise conduct of the marital relation, or it may be one of the results of a constipation or of some general circulatory disorder. Any one of a similar multiplicity of causes may produce almost any one of the alterations of mechanism which occur in either sex. Treatment must then be directed not merely to the individual change of mechanism, but to the cause which produced it.

This section and the next will be devoted to the consideration of these underlying causes in the two sexes.

Chronic passive congestion is never a primary condition. It, moreover, tends, when once established, to be long continued, and since it may then be in itself a cause of many of the disturbances in the mechanism of fertility, it occupies a position which lies between the mechanism of fertility and the primary causes of its disturbance which are to be described in this and the succeeding section. It is equally important in both sexes, and since references to it both as a cause and an effect will occur in almost every chapter throughout the book, its importance seems to warrant the devotion of this brief special chapter to its consideration.

It is very essential to a clear comprehension of this subject that we should make, and bear in mind throughout, a sharp differentiation between the active congestions which are normal and the passive congestions which are always abnormal. The general term "congestion"

is too frequently employed by the profession in a vague and loose way and with neglect of this important distinction. There is, of course, a very essential difference between the acute congestions which are due to an increase in the arterial supply of an organ, and the chronic passive congestions in which the condition present is a dilatation of the veins and a distention of the organ by venous blood.¹

In active congestion with dilatation of the arteries and a normal condition of the veins, the circulation in the organ is rapid, and it receives an abundance of fresh and useful blood. Some degree of active congestion is physiologically and normally present when any organ is in a state of high functional activity. The active congestions are then physiologic in nature. They usually affect the whole system of organs which are concerned with the particular function that is at the moment in operation.

In the chronic passive congestions, in which there is dilatation of the veins without any great increase in the arterial supply, there is, on the other hand, a slow circulation of venous (that is, of partially exhausted) blood. This condition is never normal, it always leads to inactivity, and usually to functional derangement of the organs so affected. It may be caused by any

¹ The condition of the general circulation should always be known, since such an abnormality as, for instance, a leaking valve in the heart may make a tendency to passive congestion throughout the body, but though any such condition must be allowed for, our special subject here is the congestions which are localized in one organ, or system of organs, as a result of conditions peculiar to those organs.

obstruction to the venous return from an organ; and in that case is usually limited to the single organ, or even part of it, which is drained by the obstructed veins. It may also be a result of too great frequency, or too long continuance, of the otherwise normal, active congestions; and even in this case is frequently localized, or essentially localized, in some one organ of the given physiologic system.

Passive congestion may occur in any portion of the body, but a brief consideration of the physiologic peculiarities which characterize the circulation of the genital organs in both sexes will show at once the reasons for its greater importance in these organs than in any others. It is, of course, well known that dilatation of the erectile tissues which are present in the generative organs of both sexes is in part due to the physiologic appearance of obstruction to the return of venous blood, but it occurs when the organs are functionally active. The arteries are then dilated, the character of the blood with which the tissues are temporarily overfilled is arterial, and with the disappearance of the stimulus which has caused the dilatation the organs empty promptly and completely. This is, then, in effect an active congestion of functional origin and is normal and innocuous.

In the course of the succeeding chapters it will become easily apparent that the chronic passive congestions which occur in these organs have, as would be expected, a quite different character and significance. They are always abnormal and long continued. In them

the organs are distended by venous blood, and edema of the tissues, with increase in the quantity of the secretions of the mucous membranes, are inevitable consequences of this condition. Hyperleukocytosis appears sooner or later, and genital mucous membranes in this condition seem peculiarly liable to infection, either ascending or, possibly at times, of hematogenous origin. The tubular glands of the cervix or prostate usually become distended by the increased secretion, and if the mildest infection enters them it tends to become localized and long persistent.

Chronic passive congestion is, in short, a condition which contributes importantly to many of the failures in the mechanism of fertility, and its presence should never be overlooked in the analysis of any case of sterility.

CHAPTER V

COMPLETE AND PARTIAL ARRESTS OF DEVELOPMENT

THE development of the genetic or reproductive organs varies from that of the somatic or general system, in that while the development of the somatic system is steady and progressive from birth, through infancy and childhood, into maturity, the organs of the genetic system of either sex remain arrested and infantile until the period of puberty supervenes. These organs then develop with great rapidity and often become essentially mature well before somatic development has been wholly completed. It is sometimes well to warn parents that both boys and girls of very immature general appearance are frequently capable of reproducing the species.

Arrests in the development of the reproductive organs may occur either during the intra-uterine life of the fetus or at the time of puberty, and these two varieties of arrested development are essentially different in their relation to our subject.

Arrests during intra-uterine life result in easily recognized gross abnormalities which are thoroughly familiar to every gynecologist. In some cases, such as, for example, an absence of the vagina with rudimentary uterus and ovaries, they are irremediable, and so far

complete that puberty does not appear. These are the complete arrests of development. In other cases the arrest is merely partial, and results in the presence of abnormalities of shape in the organs, such as double vagina or uterus, or both, and imperforate hymen or os uteri. In these cases puberty not only appears in due course, but may even result in complete development of the organs, though still in their abnormal forms. The diagnosis of all these cases is ordinarily easy. Their treatment is always operative, its principles are thoroughly understood, and may be found in any text-book. They are usually detected and given the appropriate treatment by the first gynecologist who sees the case. For all these reasons they are outside the scope of this book and will receive no further mention here.

Arrests of development at the time of puberty may be either partial or complete.

Complete arrest at this time is comparatively rare. In such cases the organs remain infantile and menstruation does not appear. In some of them the woman is decidedly masculine in appearance, but in many others the secondary sexual development is fairly complete, *i. e.*, the woman is feminine in figure and appearance, and the abnormality is detected only on vaginal examination.

Partial failures of conpubertal development are, on the other hand, extremely common. The functional effects which result from them are responsible for a large fraction of all the sterilities which are met with

in practice, but they do not produce evident gross abnormalities, they are not easily detected, and have attracted but little attention. To their consideration this chapter will be devoted.

The age at which puberty appears varies considerably with the climatic and other conditions of the environment. In girls in temperate climates and under the ordinary conditions of civilization the beginnings of sexual development usually occur at about twelve, and the process is, as a rule, substantially completed at fifteen to sixteen. Menstruation appears at about the middle of the process and conception is possible from about this time.

At about twelve the child has a vagina, uterus, tubes, ovaries, breasts, etc., which differ but little, if at all, from those of the newborn infant, and the proportions of her bones and muscles (*i. e.*, her figure) differ but little from that of a boy of the same age. In somewhat less than four years she develops the organs of a mature woman, and with their development her bones, muscles, and many other organs undergo extensive changes which are known as the secondary sexual characteristics, and which give her the appearance and the functional peculiarities appropriate to her sex. In point of fact, in the woman the activities of almost every organ in the body are modified to a greater or less extent to fit her for the varying phases of the menstrual month, and for the greater changes incident to pregnancy, labor, and nursing.

The demands made upon the general health by this

rapid development of the sexual organs and by the correlated changes in the general physiology are greater than is generally realized, and in the present state of our civilization, with its many other demands upon the growing girl, partial failures in this development—partial persistences of infantile conditions—are extremely common and are often of great genetic significance.¹

Such failures of conpubertal development occur in every degree, from those in which the examination of a mature woman shows her to have absolutely infantile ovaries, tubes, and uterus (and in the most extreme cases even an infantile vagina), to those in which the organs are otherwise normally developed, but in which there is an abnormal degree of antelexion of the cervix, which is, in fact, a partial persistence of an infantile condition in this organ, and should, therefore, be classed as a developmental failure.

Complete failure of puberty and the persistence of an actually infantile condition of the uterus, tubes, and ovaries in a woman of mature age constitutes a sterility which is usually permanent and irremediable, but, as has been said, this condition is, fortunately, rare. The lesser degrees of failure of development—the underdevelopments of one or all of the organs—are, however, common; and, indeed, the less the degree of under-

¹ In the male the physiologic changes of puberty are far less fundamental and far reaching and failures of development are therefore far less common than in the female. For this reason educational and other strains upon the girl of from twelve to sixteen, cannot be judiciously pushed to anything like the extent which is permissible in the case of her brother.

development, the more common it is. In cases in which such a woman marries early in life and while still young enough to have some of the developmental impulse still present, these underdevelopments of minor degree may disappear spontaneously as the result of a renewed growth which often appears under the stimulus of the marital relation. In similar cases in which marriage is deferred until the individual is wholly mature and the pubertal impulse has been wholly lost, the arrest is usually permanent, and frequently causes a sterility which is permanent if left without treatment, but which is in these minor arrests usually promptly remediable if recognized and properly treated.

The existence of any degree of underdevelopment in the organs always implies some degree of imperfection in their functional activities, and therefore involves a liability to failures of function under strain. During maidenhood the only stresses which are placed upon the organs are those incident to menstruation, but with the adoption of a physiologically active sexual life other stresses are imposed, and in many individuals of this type, whose organs have functionated normally up to the time of marriage, the supervention of the marital relation with its recurring congestions institutes the changes in the secretions and in the ovaries which have been described in Chapter III as constituting failures in the mechanism of fertility. These changes are in such cases at first slight, but they progressively increase, and, in consequence, women of this type who come under expert

observation after a short period of sterile married life are usually more easily relieved than those who have been long married before receiving proper treatment. Yet this class of cases, even when taken as a whole, is more amenable to treatment than any other. It constitutes more than a quarter of all the female sterilities which we see, and in it treatment has yielded nearly 80 per cent. of successes, even though the list includes many cases which have been first seen after many years of sterile married life.

A large series of cases of this nature necessarily presents so many variations in detail that to describe all of them would expand this chapter to an extent incompatible with the scope and plan of the book as a whole, but it is believed that a description of the most common type will so far elucidate the subject as to enable the intelligent practitioner to recognize the varieties as they appear in practice and to devise the appropriate treatment with which to remedy them.

In the most typical cases the general appearance of such women is fairly distinctive.¹ In really typical cases of this class the woman is slight, has small breasts, and

¹ Since arrested development of any organic system is usually accompanied by the stigmata of underdevelopment in other regions it would be expected, *a priori*, that such cases would show some signs of general underdevelopment, and this is the rule; but we may note here that the genetic and somatic systems are so far separated that exceptions to this rule do occur. Instances are, in fact, seen where women of mature and thoroughly feminine appearance are found on examination to have genetic underdevelopment of considerable or even high degree, and this possibility must be remembered; yet, as a rule, even in these instances some suspicion of the nature of the case appears to the expert on mere inspection of the woman.

her figure shows the long, straight, boyish lines which are characteristic of immature individuals of both sexes. They are not infrequently undernourished as well. A noticeably small, plump type of woman with small breasts which on palpation contain almost no breast tissue, and with a history of scanty menstruation and but slightly active sex impulses, is also not uncommon.¹

On examination the vagina, though often rather small, is usually developed to within the limits of normal variation, and the uterine body in the type case tends to the small normal, the intermediate portion being often smaller and less firm than the fundus. In the type case, however, the cervix is always less developed, *i. e.*, less remote from the infantile in size and shape than any other portion of the organ (Fig. 9). It is always sharply anteflexed and the os is small or even pinhole. When it is urged backward by the examining finger it is found to be more or less fixed in its forward position by an overfirm attachment to the tissues about the symphysis. This is due to an arrest of development in the subpubic fascia first definitely described by Goffe, and commonly known as Goffe's ligament, though this is an incorrect term, as it is really a somewhat broad fascia. It is an analogue in the female to the triangular fascia of the male and is the only rigid attachment of the uterus. Its undue shortness and consequent tension is

¹ In this latter type of woman some evidence of thyroid or pituitary deficiency may frequently be obtained, and it is to be hoped that with increasing knowledge this fact may furnish us with methods of care during puberty, which will prevent the occurrence of this class of failures.

the essential feature in the production of the antelexion which is always present and which is of much functional importance in cases of arrested development.

This condition of sharp antelexion is normal in the uterus of infancy and childhood, and at that time is

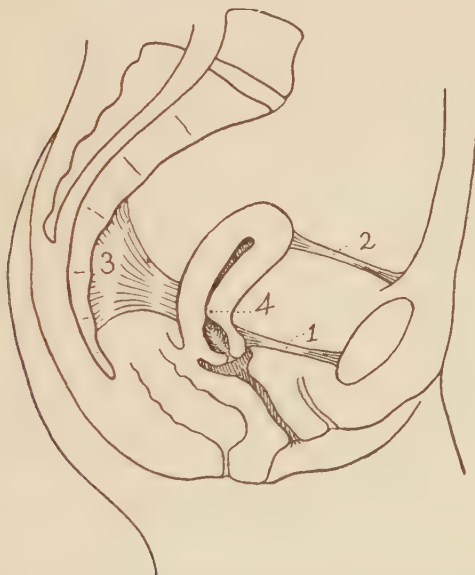


Fig. 9.—Mesial section through a uterus with fixed antelexion of the cervix, diagrammatic: 1, 2, and 3 represent the lines of force due to the action of (1) Goffe's fascia, (2) the round ligaments, (3) the uterosacral ligaments, rather than those structures themselves; 4, the obstruction from angulation is at the region of the internal os. The cervical canal is shown distended by retained secretion behind a pinhole external os.

harmless, since the uterus is inert and non-functional, but it should normally disappear before the menstrual function appears.

The uterus is, in effect, a thick-walled flexible tube, and the mechanical condition produced by forced ante-

flexion is closely similar to that which is easily illustrated by sharply bending a rubber tube.

Even in the extreme anteflexion which is characteristic of the thoroughly underdeveloped cervix the passage around the angle is undoubtedly sufficient for daily uterine drainage until some circumstance occurs to increase the sharpness of the flexion or to increase the amount or thickness of the fluids which must escape, but both these phenomena appear with the occurrence of menstruation.

At the beginning of the menstrual period the uterine and cervical walls become congested, *i. e.*, swollen by an increased supply of blood. With this swelling the anterior wall is so crowded in the angle that the uterus would necessarily straighten out if it were not for the action of the uterine ligaments, but the round ligaments hold the fundus forward, the uterosacrals draw the mid-portion of the organ backward, and the shortened Goffe's fascia holds the cervix firmly forward (Fig. 9). The inevitable result of this fixed position and of the increased thickness of the anterior wall and, indeed, of the uterus as a whole as its walls fill with blood, is an increased sharpness of the bend at the point of flexion, and with this the anterior and posterior walls are, of course, pressed more closely against each other, and the necessary drainage of the organ is lessened or at times annulled. At the same time the amount and consistency of the uterine flow is greatly increased by the appearance of the menstrual blood. In those cases in which the persistence of

the infantile condition of the cervix is of high degree and the body of the uterus is at the same time large enough to furnish an active menstruation, which is the type condition, dysmenorrhea appears from the start. The first menstruation is more or less painful, each such disturbed menstruation tends to leave a little chronic congestion behind it, and the dysmenorrheic pain, therefore, tends to increase and become habitual. Such dysmenorrhea and the chronic congestion throughout the month which it eventually establishes then usually create the changes in the secretions and often in the ovaries which constitute the corresponding failures in the mechanism of fertility, and which frequently exist in these cases even in advance of marriage.

If the degree of ante flexion is less extreme it may fail to produce dysmenorrhea or other consequences during maidenhood, and some few such cases may be fortunate enough to become pregnant immediately after marriage, but if this fails and the frequently recurring congestions of married life are added to those of menstruation, chronic congestion soon becomes established, and the increased sharpness of the obstruction in the uterus becomes constant. There is not only an appearance of postmarital dysmenorrhea, but the daily drainage of the ordinary uterine secretions becomes insufficient; between the effects of lack of drainage and the increased amount and stickiness of the cervical secretion which is a direct consequence of a chronic congestion, they become impermeable to the spermatozoa, and from this

fact alone an effective failure in the mechanism of fertility has become established. If this condition is allowed to persist during a number of years of married life the cervical obstruction not only tends to increase, and to result sooner or later in one of the mild infections of the cervical secretions,¹ but for some reason, which is as yet obscure, the loss of ovarian function which forms another step in the mechanism of sterility usually follows; and hypertrophy of the uterine mucous membrane or even endometritis, and consequent loss of nidation is also frequently coincident.

This is briefly the natural history of the type case, but the practitioner must remember that he will see every possible degree of variation in the proportionate underdevelopment of the cervix and uterine body, and also of the tubes and ovaries, and that the symptoms and consequences will vary with these variations.

In some cases the dysmenorrhea will be slight or absent; in some it will be prominent; in some cases the increase in consistency and amount of the cervical secretions will be promptly followed by a heavy leukocytosis (the result of some slight degree of infection); in others this complication will not appear for a long time. In some cases loss of ovarian function follows almost at the start; in others it appears late.

Careful study of the whole uterus by palpation and of the shape of the orifice and canal with the sound; in com-

¹ The absence or decrease of the downward current which results from inspissation of the secretions of course favors the entrance of bacteria from the vagina.

bination with estimation of the degree and character of the alterations in the secretions of each part of the canal as observed by the microscope, together with estimation of the size and shape of the ovaries, if possible in the varying phases of the menstrual month, will show the attendant the reasons for the variations in the symptomatology. With increasing experience the exact conditions of each case and the choice of expedients for their relief will become clear to his mind.

When the underdevelopment is either chiefly or wholly confined to the cervix and does not lead to essential alterations in the secretions during maidenhood, when the other conditions, including high fertility in the husband, are such that prompt pregnancy follows matrimony, the rapid development of the organ as a whole which is a part of pregnancy is the end of all trouble, and this is usually followed by a corresponding increase of development in the secondary sexual characteristics. These are the women who develop and improve in all ways with maternity, as every one has at times seen.

These cases are promptly and thoroughly remediable if the anteflexion of the cervix is relieved and drainage restored by a simple plastic operation, which should, however, be preceded, as a rule, by a dilatation and curetage. The curetage of the cervix should always be deep, thorough, and followed by disinfection with iodine or iodophenol. If the character of the secretion shows that the uterine mucous membrane is considerably altered in character, light curetage of the cavity may be

indicated, and if an actual hypertrophy is present, deeper curetage of the cavity may be proper, but the performance of each of these steps should be weighed in accordance with the conditions in each individual case.

If the os uteri has been anything but ample, its permanent enlargement should be the next step. No mere dilation should be trusted, since recontraction almost always recurs within a few months.¹

At the conclusion of the discission the anterior vaginal wall should be incised transversely just above its cervical reflexion, Goffe's fascia should be exposed and also divided transversely. All the anterior tissues should then be separated from the cervix by blunt dissection with the finger, which should be carried high and widely to both sides; and the incision should then be closed by transverse sutures, thus elongating all the anterior attachments and throwing the cervix back into the hollow of the sacrum. Quite free hemorrhage is sometimes encountered during the operation, but since the only vessels divided are those in the vaginal plate, it will be entirely controlled by a careful suture. At the conclusion of this operation the cervico-uterine canal will be straight, the antelexion having been disposed of, and permanently good drainage is an almost invariable result.² Such drainage in itself establishes a tendency toward a disappear-

¹ In the very few cases in which pinhole os occurs without much antelexion and in which study of the secretions shows that the alterations which ordinarily follow retention have not as yet occurred, a simple dilatation may occasionally be followed by a prompt pregnancy, but this result is exceptional.

² Consult also Chapter XX, on Surgery of Sterility, p. 249.

ance of the disturbed conditions in the mucous membranes, but some subsequent office treatment of them is frequently necessary, and, if so, should be continued until microscopic examination of the secretions shows them to be entirely normal.

In conpubertal antelexion of the cervix the routine dilatation and curetage which is too often applied to sterile women in a happy-go-lucky spirit and without the plastic is usually worse than useless. Its effect is purely temporary, the vicious condition reappears before the secretions have had time to return to the normal, and the woman has not only undergone an ineffective operation, but is often the worse for it, since the deep curetage of the uterine body which many practitioners indulge in often decreases and disturbs menstruation for a long time after its performance.

We cannot too strongly condemn the use of the intra-uterine stem in these cases. It is sometimes attractive because its use is easy and convenient for the practitioner, and because there is no doubt that it is occasionally followed by pregnancy, but the percentage of results so obtained is no more than a small fraction of those which follow a properly executed plastic operation, and unless prompt pregnancy follows the subsequent chances of the woman are always very greatly diminished and sometimes destroyed by its use. The cervical mucous membrane at the angle of antelexion usually undergoes necrosis from the pressure of the stem, and is then replaced by a cicatrix which often contracts progressively, and which,

probably, always results in the end in a disadvantageous alteration of the cervical and uterine secretions. Many cases are, moreover, permanently sterilized by closure of their tubes from infection occurring during the use of the stem, and this is one of the instrumentations after which such a closure often occurs without exciting symptoms of degree sufficient to attract attention.¹

Cases of the underdeveloped type, in which disturbance of the mechanism of sterility is limited to the cervical secretions only, are seen from time to time and are always very favorable, but they form a very small fraction of the class. In many cases early, and probably in all such cases later, failure of ovarian function supervenes, and on sufficiently close observation the ovaries are found affected.² In some few of such cases local depletion and careful constitutional treatment of general physiologic disturbances may be enough to restore ovarian activity, but more often a conservative operation on the ovaries must be performed. This is, of course, abdominal and consists essentially in the relief of tension in the ovary by evacuation of its contents by puncture or dissection of the retained follicles, or by resection of portions of the ovary, together with scarification of its surface if necessary, the selection of the appropriate method being determined by the situation and character of the offending bodies. With increasing experience the choice becomes increasingly easy, and with a judicious deter-

¹ Consult Chapter VI, p. 89.

² Compare Chapter III, p. 55.

mination of the means employed the percentage of permanent relief to the ovaries is exceedingly high.

The ovarian operation is not likely to be successful unless it is performed in combination with the institution of uterine drainage by the plastics, but the combined operation is not severe and the results obtained are good.

SUMMARY

The type case shows both localized and general failure of development.

The disturbances in the mechanism of fertility by which the sterility is finally produced are the appearance of hostile secretions as a result of imperfect cervical drainage, and later the arrest of ovulation which appears to be associated therewith.

The treatment is usually operative.

The prognosis is good.

CHAPTER VI

THE SPECIFIC AND NON-SPECIFIC INFECTIONS

IN dealing with the infections in ordinary practice the gynecologist is usually concerned only with their acute stages and the convalescence therefrom. Their signs, symptoms, and treatment from this standpoint are covered by all the text-books and will not be repeated here. In the treatment of cases of sterility the infections must be approached from an entirely different standpoint. Such cases usually present only the remote consequences of former and long past infections. The physical signs which represent the presence of these quiescent lesions are often so slight that they escape detection by routine methods of examination, and the symptomatology is often trifling and obscure. It is usually considered entirely unimportant by the patient, yet conditions of such apparently trifling nature may be entirely sufficient to cause permanent sterility.

The nature of the specific infections is so well understood that this chapter will deal with them briefly and only from this standpoint. It must deal at greater length with the milder infections which are due to other organisms. These infections are of great importance to sterility not only because they are often so mild as to have been unnoticed and are acquired from sources of

infection which are not always thought of, but also because they are very frequently met with in the class of cases which consult us for sterility.

THE SPECIFIC INFECTIONS

Tuberculosis appears in the genital tract of the woman chiefly in the form of tubercular salpingitis, and this infection is most apt to occur at or about the time of puberty. From the original focus in the tubes the disease, if unchecked, may spread to the abdominal cavity thus leading to a tubercular peritonitis, or in rare cases to the tissues of the uterus and cervix. Practically speaking, we are, however, concerned from the point of view of sterility only with the milder cases which have been limited to the tubes. When such cases are seen in later years there is usually little or no genital symptomatology, but on careful palpation under anesthesia the tubes are sometimes palpable as small, firm, resistant bodies in the upper portion of the broad ligament, and in any event insufflation will show them to be closed. At operation such tubes usually prove to be slightly thickened and to contain at intervals small quantities of cheesy material. If, as is usual, both tubes are affected, the prospect of pregnancy is practically nil. The differential diagnosis between old tuberculosis and other and more hopeful causes of closure is often difficult or impossible without an abdominal incision, but weight should always be given to any history which is suggestive of tuberculosis in early life.

It has long been known that Syphilis during its active stages usually produces practical sterility in the form of repeated miscarriages. It is less generally recognized that it very frequently produces complete sterility in the form of death of the impregnated ovum before its escape is recognizable; and probably also in many cases by decrease of the vitality of the gonads, in either sex, to a degree sufficient to prevent impregnation. This is, however, often a fact, and the disease is so far an effective and common cause of sterility that the possibility of its presence should be considered in every case of sterility, and if the general examination of either patient raises the slightest suspicion of it a Wassermann should be taken, even though all possibility of the disease is denied. In our experience a positive result has not infrequently been obtained in cases where it has been least expected. In such cases it is not only unlikely that pregnancy will be obtained without treatment of the syphilis, but it is, moreover, usually undesirable even if obtainable. All other treatment of the sterility should then be suspended until the syphilis has been cured. Under modern treatment the prognosis is, of course, usually good; the diagnosis is too well known to the profession to need description here.

Acute Gonorrhea in the female often results in complete sterility. The natural history of the disease is that the first consequence of an infection is an acute and very noticeable purulent vaginitis, which may or may not be complicated by cervical infection from the start, *i. e.*,

from the time when it is first observed. If the disease is subjected to treatment while it is still limited to the vagina it may sometimes be arrested while it is still purely vaginal, but so fortunate a result is somewhat rare. In these fortunate cases it does not cause sterility and is not important to us here.

In the majority of cases the cervix is infected either at the start or very shortly afterward, and the infection then usually in the end extends to the tubes. Gonorrheal infection of the tubes nearly always results in their closure and, moreover, frequently so far ruins their mucous membrane as to render the prognosis practically hopeless even after operation. Comparatively few women who have been through a complete and severe attack of gonorrhea ever subsequently conceive.

In most treatises on sterility gonorrhea is described as an extremely frequent cause of the tubal sterilities, but our experience leads us to believe that this statement requires modification. It has become quite evident to us that the frequency of sterility of gonorrheal cause varies widely with the social class of the patients under study. Most published statistics have been drawn in whole or in part from hospital reports, and for the class of cases seen in their clinics are probable accurate, thus Curtis¹ has reported a series of 300 cases of salpingitis from his hospital clinic, all of which were, of course, sterile, in which gonorrhea appeared as a cause in 70 per cent., other pyogenic organisms in 15 per cent.,

¹ American Gynecological Transactions, 1921, vol. 46, p. 243.

and tuberculosis in 5 per cent. (though many of his gonorrheal cases were complicated by the presence of colon bacilli), and in our hospital work we have recognized the existence of high percentages of gonorrheal cause among the tubal inflammations. On the other hand, among our private cases the percentage of tubal sterility of gonorrheal origin has been very small, so small that it would be foolish to state it statistically from any series of less than several thousand cases.

This marked difference requires explanation. Every physician knows that a history of past gonorrhea in the male is far from rare in any series of cases, but in the class of sterilities seen in private practice a history of acute gonorrhea in the female is comparatively rare. Men of the intelligent classes rarely expose their wives to contact with acute gonorrhea. Such men usually submit themselves to treatment early and persist in treatment for a reasonable length of time, and we now know both that the gonococcus usually disappears from the infected secretions comparatively early in the course of the disease—*i. e.*, at or soon after the end of the acute stage—and that after its disappearance contact with the discharge does not produce gonorrhea. This statement may seem to some surprising because it was formerly taught that the remote sequelæ of gonorrhea were contagious; and because too many of the profession still accept this view, in spite of the fact that it is contradicted both by modern bacteriologic knowledge and by the natural history of the cases. It is, of course, possible to

have gonococci remain alive and virulent for some time in the tubular glands of the prostate or cervix, but even here they rarely persist for many years. Long-continued evidence of continuing infection in any part of the genital tract is more often due to the presence of the common pyogenic organisms, which habitually persist long after the gonococci disappear.

The old view that any chronic genital infection in a married woman, even unaccompanied by the history of an acute onset (the so-called marital gonorrhea), was usually or always the result of unrecognized gonorrheal sequelæ in her husband rested, first, on incomplete bacteriologic information, and, second, on a somewhat blind belief, consequent to this, that all men whose wives had genital infection of any character and who denied gonorrhea were necessarily lying. As a matter of fact, it is usually easy to differentiate between the specific and non-specific infections of the female by study of the history. If a woman is infected by the gonococcus the onset is acute, all the secretions become actively purulent, and the course of the disease is typical in even the mildest cases.¹ If this was not the case it may be accepted as a general rule that the infection was not gonorrheal; again, no one can see a long series of sterilities without learning that the male partners are usually so anxious to assist the physician in every way that they are very unlikely to falsify their history; and, further,

¹ Even in those cases in which the infection is arrested in the vagina by energetic early treatment the attack is distinctive at the time when it is seen.

and perhaps more important to the argument, a study of the converse side of the question from the viewpoint of modern bacteriology furnishes abundant reason for assigning most, if not all, of such affections of the female genitals to infections by other bacteria.

NON-SPECIFIC INFECTION¹

The accidental, non-specific infections have a natural history which contrasts strongly with that of gonorrhea. They vary in their course not only with the virulence of the infecting organism, but even more with the method by which it is introduced. From a clinical standpoint they are, perhaps, best classified as obstetric, instrumental, and marital. Their main characteristics are that their onset is often mild, not infrequently so mild that the acute stage escapes recognition; and that in the later stages the tubes are more often flaccid and non-palpable than in the gonorrheal cases, even though they are closed; also in the gonorrheal cases the tubal symptomatology, even in the later stages, is usually much more marked.

In the first class of accidental infections both the course of the disease and the time of appearance of the symptoms will show it to be in all probability of obstetric origin, *i. e.*, due to mild infection of the uterus and tubes, most frequently by the colon bacillus, at the time of labor, miscarriage, or abortion. In obstetric infections

¹ Throughout this section the reader should remember that in cases of sterility we are usually dealing only with the remote results of past infections.

the acuteness of the onset varies with the character of the bacterium involved.

The more virulent and serious infections are usually caused by the streptococcus, are easily recognized at the time, are described as such by the patient, and need no further mention in this connection.

The milder cases induced by less virulent bacteria are often unrecognized at the time, are unknown as such to the patient, and are consequently often unmentioned in her history when she seeks advice about sterility, but some mild symptomatology can usually be obtained by cross examination, and the time at which these symptoms were first noticed is then usually suggestive or distinctive.

In the more severe of these mild cases there may be at the onset an elevated temperature of noticeable degree, and it is frequently accompanied by moderate abdominal distention and tenderness. Vaginal examination at this time would show distention of one or both tubes, but localized symptoms are usually absent or slight, the attack is often of short duration, the tubes empty promptly through the uterus, and the temperature falls. Since these salpingites often occur in the early days of the puerperium a vaginal examination is very generally avoided, and with the subsidence of the symptoms the whole disturbance is passed over as non-septic, and as the result of delayed action of the bowels, or of an inter-current and passing general infection. The patient will then be entirely unaware of the importance of such an attack to her subsequent condition.

In the least acute cases the elevation of temperature, distention, and tenderness may be so slight as to attract very little attention, or to be passed over without any real attempt at diagnosis, but even such apparently trifling infections as these surprisingly often result in the end in closed tubes. The subsequent pelvic symptomatology is usually very slight, and although the tubes remain closed their condition will then remain unsuspected until sterility leads to a specialized examination. Such unrecognized salpingites of obstetric origin have been by no means infrequent in our experience in the so-called one-child sterilities. Persistent endocervicitis of degree sufficient to cause sterility is still more common.

In the second class, the instrumental infections, severe infections are now rare. When they do occur they are easily recognized, but even then they are too often explained to the patient under some other name, and are, consequently, unrecognized as such by her. When such a patient appears in later years and to later attendants as a case of sterility, the history which she gives is often obscure, but cross examination of her past genital history will usually reveal the symptomatology of an acute infection after an operation or examination, and the time at which the onset occurs makes its source evident.

The more frequent mild instrumental infections are attended by but slight immediate symptomatology. They differ from the mild obstetric infections which have just been described only in the fact that they date from

an operation or examination instead of from a delivery at term or from a miscarriage. They are almost equally liable to be passed over without diagnosis, and to be unsuspected afterward until a special sterility examination is made.

All that has been said of the two classes just described is even more true of the next class, the non-specific marital infections. Here there is usually no history of pregnancy or operation, but on microscopic examination of the cervical secretion the evidences of past infection are found, and in too many cases one or both tubes are closed. The natural history of these cases distinguishes them easily from the gonorrheal cases. The extreme mildness of their onset and the mildness of the continued course of the disease are both in marked contrast with the history and characteristics of gonorrhea. They are, moreover, thoroughly in accord with all that is known of the infections of other organs by pathogenic bacteria which have been in one way or another lessened in virulence.

The source of such cases is probably to be found in non-specific, chance infections during coitus. It must be remembered that coitus is not conducted under aseptic precautions; that intromission inevitably and invariably conveys into the vagina the colon bacilli (and usually many other bacteria), which are always present on the skin of the perineum and vulva. They are normally introduced only into the vagina, and even if a few are drawn into the cervix, they are usually washed away

by the postcoital flow. Under these circumstances their introduction is ordinarily harmless since they are rapidly rendered innocuous by the bactericidal action of the vagina. It must, however, inevitably happen that in a few cases, and especially where chronic congestion is also present, these natural safeguards are overcome, *i. e.*, that in occasional individual cases colon bacilli or other mildly infective bacteria remain in the cervix in sufficient virulence and quantity to effect a mild but lasting infection of its secretions. In most such cases the infection results in nothing more than a localization in the tubular glands of the cervix, but the evidence which accumulates in the course of a long series of cases shows that in a small percentage the bacteria must succeed in ascending beyond the cervix and effecting a mild infection of the tubes.

It will be noticed that we have made no suggestion of attempting a differential diagnosis in these cases by direct bacteriologic examination. This is, in fact, seldom of any value, since the contents of the vagina habitually contain bacteria of many varieties, and those of the cervix and uterus can seldom or never be obtained without some contamination; while the unmixed secretion of the tubes cannot be obtained by any method other than an abdominal incision. Moreover, in the chronic stages at which such cases are habitually seen by the expert in sterility, the organisms which were originally present have usually disappeared and the secretions are bacteria free. The differential diagnosis between the milder cases which occur so frequently in these three

classes of accidental infections and those of gonorrheal origin must then always rest, as has been said, upon the probabilities as derived from their history, and upon its marked contrast to the acute onsets and more severe subsequent symptoms which are characteristic of gonorrhea.

Some physicians whose practice has not led them to an independent study of any large number of such cases, and whose minds have been thoroughly imbued with the older teachings, may perhaps hesitate to accept the above explanation of the causation of many cervical infections, and of not a few mild chronic salpingites. To them one statement may, at all events, be made without reserve. In our experience with operative cases instances of small undistended but permanently closed tubes, which had been unsuspected by the patient and unrecognized by previous attendants, have been extremely common, and in not a few of these cases the trouble has been confined to one side.¹

The acceptance of this fact is a matter of much practical importance in both the diagnosis and prognosis of sterility.

We have so far considered mainly the variations in the history, symptomatology, and prognosis of infections which result from the varying bacteria which caused them. We must now enter upon another branch of the subject. Infection of any part of the genital tract, specific

¹ Cases in which one tube is closed but the other is normal are usually sterile, but have an extremely good prognosis after operation.

or non-specific, is usually sufficient to produce at least temporary sterility of the individual so affected, but both its importance and its relation to treatment and prognosis are much influenced by the portion of the canal in which it is localized.

An infection which is limited to the vagina either spontaneously or by treatment is usually of short duration and is then wholly unimportant.

Infection limited to the cervix is very common. It is then always mild, but is often very persistent, being localized usually in its tubular glands. The gross appearance of the secretion in such cases varies from mere cloudiness to distinct mucopurulence. The final diagnosis is made by microscopic examination of a portion of the secretion taken from well within the cervical cavity, when the heavy leukocytosis in infected cases is at once apparent and is diagnostic. Bacteria must have been present at the onset, but, as has been said, are rarely evident in the chronic cases.

In many cases the mouths of the glands become occluded, and distention of them by retained secretion often results in the formation of the so-called nabothian cysts. Every one is familiar with their appearance on the vaginal surface of the cervix, but it is important to remember that they are probably equally common under the mucous membrane of the canal, within the os. Those which appear on the vaginal surface of the cervix rarely discharge their contents spontaneously, but are important as foci of absorption, and when numerous

often cause noticeable constitutional depression. Those which reach the surface within the canal are situated at or near the mouth of the glands, and from time to time discharge their contents into the cervical canal. Their presence is in either case conclusive evidence of the existence of a cervical abnormality of a degree which is usually sufficient to cause sterility.

The milder cases of cervical infection may sometimes be effectively relieved by repeated topical applications of iodine or iodophenol (two-thirds tincture of iodine and one-third 95 per cent. carbolic) within the canal, but in all but the mildest cases curetage of the cervical mucous membrane is usually necessary. When the os is well open and the secretions drain freely permanent relief may sometimes be obtained by repeated mild curetage with a sharp curet in the office, each curetage to be followed by the topical application; and if this procedure is gently performed, it is not essentially painful, and is well borne by most patients. In the majority of cases it is, however, best to begin treatment by a deep curetage under ether; though even then the repeated mild curetage is often necessary later. When the os is small and inspissated secretion is retained above it the institution of permanently free drainage by enlargement of the os is essential to success. For this purpose mere dilatation is seldom sufficient. Permanent and satisfactory results are seldom obtained unless the os is enlarged by a dissection, with which curetage of the cervical cavity should always be combined.

In all these cases it is essential to fertility that treatment should be persisted in until microscopic examination of the secretions show that they have become normal and, moreover, that they remain normal after treatment has been intermitted.

When a mild infection has not been arrested in the cervix, but has extended to the uterine cavity also, it usually extends into the tubes as well. In the cases in which the uterine cavity is affected without the tubes there is but little diagnostic evidence that it has extended beyond the cervix until the case is submitted to curetage. For this reason, in every case of cervical sterility in which an operative curetage is necessary, the deep curetage of the cervix should be followed by the introduction of the curet into the uterine cavity for diagnostic purposes. Every portion of the cavity should be carefully explored with the curet, and if redundant mucous membrane is found, either generally or at any one point, it should be cureted out. In cases of sterility, in particular, curetage of the uterine cavity should always be made as mild as possible, since an overdeep curetage of this portion of the mucous membrane often results in prolonged oligomenorrhea and probably considerably decreases the chance of a successful pregnancy.

Tubal infection by any bacterium implies closure of the tubes. The only treatment which offers any prospect of success is an operative opening of the tubes after an abdominal incision. The prognosis for fertility is never good, but in thoroughly quiescent chronic cases

occasional successes are obtained and such operations are usually considered as justified. In this opinion we coincide, provided that the patients decide upon operation after having had the rather unfavorable prognosis plainly and fairly set before them.

As will be shown in a later chapter, it is possible that the results of dilatation of the tubes after operation, by insufflations with CO₂, may hereafter modify the unfavorable prognosis in these cases.

One other condition belongs under infections, and must be mentioned here. It occasionally happens that the tubes are shut off from the ovaries by adhesions incidental to localized peritonitis of appendical or other origin without destruction or essential injury to the tubal mucous membrane. On examination such cases can never be distinguished from closure due to salpingitis, except that a suspicion to this effect may sometimes be raised by the probabilities derived from the clinical history of the case, *e. g.*, from the performance of a previous appendectomy with drainage. Some hint of a differential diagnosis between these conditions may often be obtained by an insufflation, but a positive diagnosis can be made only by an abdominal incision, which also, of course, affords the only possibility of effective treatment. The prognosis in such cases is not uniformly good, but is far better than that which obtains in closures of salpingeal origin.

In some cases of appendical origin the closure is, however, limited to the right side, and though such cases are

usually sterile without operation, as a result of drainage of a hostile secretion into the uterus from the affected tube, an operation which removes the abnormal tube and leaves the other is almost certainly followed by a prompt pregnancy.

These possibilities as derived from history should be weighed in estimating the prognosis and, consequently, in discussing treatment in all sterilities which are believed to be due to closed tubes.

CHAPTER VII

DYSPAREUNIA, DISPLACEMENTS, AND NEO-PLASMS

A FULL description of every lesion which may at times disturb the mechanism of fertility, and thereby become a cause for sterility in a woman, would expand this chapter into a text-book of gynecology. Those lesions which are here described have been selected as among the most frequent and important determining causes, and as illustrations of an important and illuminative principle which the practitioner should be easily able to apply not only to them, but to any other pelvic lesion which may seem to him to be possibly productive of the sterility in a given case.

DYSPAREUNIA AND VAGINISMUS

Dyspareunia, or painful coitus, though itself a symptom rather than a lesion, is usually the result of some one of several pathologic conditions which may best be grouped under this heading. It may occur as a result of cracks, ulcerations, eczema, or other sensitive lesions about the introitus, and such cases may or may not be complicated by vaginismus, and the two may be easily included in a single description. Vaginismus is an affection characterized by painful spasm of the muscles which contract the introitus. It is probably sometimes

purely psychic in origin, it may then be regarded as a functional disorder of the nervous system. It almost invariably includes a psychic, etiologic factor, it rarely occurs except in patients of psychasthenic type; but in the majority of cases the spasm is excited by a local lesion and may then often disappear after treatment of that lesion.

Such a local condition should, then, always be searched for as the first step in diagnosis when a patient complains of dyspareunia. Eczema and similar conditions are easily detectable, but small cracks or ulcerated spots in the neighborhood of the introitus may be extremely inconspicuous, easily overlooked, and yet sufficiently painful to cause incomplete or entirely unsuccessful intromission. If once detected their treatment is usually obvious and easy, but if vaginismus is present no search for them can be considered complete unless made under anesthesia.

An imperfect rupture of the hymen is another frequent cause of vaginismus and consequent dyspareunia, and the remains of the hymen should always be put upon the stretch by the fingers during the examination. In many cases it will be found by this maneuver that the hymeneal base is still unbroken even though this may not be apparent without distention or to the eye. In such cases the fingers will receive the sensation of a fine thread-like band concealed beneath the mucous membrane and apparent only on full distention. Permanent relief is then not obtained unless this band is

broken up by overstretching under anesthesia, and thoroughly, and with care.

He who considers such a case to be of purely psychic origin without a thorough local examination under anesthesia takes a very heavy responsibility; if, however, such a search reveals no local lesion the case is likely to be best handled if it is referred to a professed expert in psycho-analysis. Such cases are usually extremely obstinate and difficult of management.

DISPLACEMENTS

Uterine displacements are frequently of importance as a cause of sterility.

The antelexions, which are commonly classed with the displacements, are, in reality, developmental deformities rather than displacements, and antelexion of the cervix, which is the only form of antelexion that is of importance as a cause of sterility, has been already described in Chapter V.

The lateral flexions and versions, which are made but little of in most text-books on gynecology, are always significant elements in the diagnosis of the cause of sterility. Their importance is chiefly diagnostic because they are always the result of contractions, usually spasmodic, in one or more of the uterine ligaments; and are always symptomatic of other more important conditions in either the uterus or the ovaries.

Deviation of the fundus alone to either side is usually the result either of the increased weight of a much

enlarged and heavy ovary on that side and of a consequently increased traction on its utero-ovarian ligament, or of similar traction from an ovary which is adherent low in the pelvis. Deviation of the cervix alone to one side while the fundus remains in or about the median line is, in our experience, always an accompaniment of engorged and inflamed lymphatics in the base of the broad and uterosacral ligaments on the side to which the cervix is drawn, and this condition of the lymphatics is itself always a consequence of absorption from an infected cervical secretion.

Lateral displacement of the uterus as a whole, in which its axis lies parallel to the median line of the body, but to one side, is a condition which is very easily overlooked, but which is usually associated with abnormal conditions in the ovary or tube of the side to which the uterus is drawn. It is almost always spasmodic, as shown by the fact that it disappears under anesthesia. Its existence should always awake grave suspicion as to the condition of that ovary and tube.

In connection with each of these conditions it is important to remember the anatomy of the so-called uterine ligaments. The round ligaments are, in fact, extensions of the uterine musculature, which they closely resemble, while both the broad and uterosacral ligaments are collections of loose connective tissue interspersed with unstriped muscular fiber contained within reflections of the pelvic peritoneum.¹

¹ In both these latter structures lymphatics and blood-vessels are also contained within the peritoneal reflections and pass through the mixture of connective and muscular tissue.

These lateral displacements are highly characteristic of many cases of sterility in the female, but, as will be perceived from what has been said, they are consequences of the existence of one or more failures in the mechanism of fertility rather than causes thereof.

The retrodisplacements, on the other hand, frequently furnish a predisposing cause for the occurrence of the secretory forms of the mechanism of sterility.

At the outset of this subject it is necessary to draw a clear distinction between adherent and non-adherent retroversions. Adherent retroversions involve, with the rarest of exceptions, tubes and ovaries buried in adhesions. These are usually a consequence of salpingitis, but may occasionally be the result of a pelvic peritonitis originating outside the genital organs, and, as a rule, of appendical origin. Women with adherent retroversion are almost invariably sterile, but they are sterile not as a result of the retroversion, but from the complicating tubal and ovarian conditions (Chapter III).

Non-adherent retroversions cause sterility in some cases and not in others, the differing result depending on whether the conditions of the individual retroversion produce a failure of the mechanism of fertility or not.

A uterus which is carried in retroversion uncomplicated by adhesions is always in a state of physiologically unstable equilibrium as compared with a uterus in normal position. As a result, probably, of tension in the overstretched upper part of the broad ligaments, and

also of the descended position of the uterine body which is a necessary part of the retroversion, the return of venous blood from the uterus and through the pampiniform plexus is impeded, and such a fundus is probably always to some degree congested, in which condition the tubes and ovaries are necessarily involved. If the congestion is uncomplicated and of mild degree, it may not, indeed, necessarily prevent impregnation, but such organs are in a state of lowered resistance to inflammation, and in them very slight happenings, such as moderate trauma, mistakes in the marital relation, or exposure to cold and wet, especially if the latter occur during menstruation, are likely to increase the congestion to a degree which results in the creation of distinctly hostile secretions, and the cervical infections to which such uteri are especially liable always produce this result. The functions of the ovaries are also easily disturbed in such cases.

The treatment of sterilities dependent on the non-adherent retroversions must then be determined largely by the character and degree of the alterations in the uterine secretion, as determined both by gross inspection and by the microscope.

If the displacement is recent, the congestion slight, and the secretions unaltered except for the profuse flow which is symptomatic of congestion, mere replacement, the elevation of the uterus on a hard-rubber pessary, and glycerin depletion for a few weeks may result in prompt pregnancy; in such cases soft-rubber pessaries must be

avoided, even the hard-rubber instrument must be cleansed at short intervals, and the pessary should be removed at the first indication of disturbance in the secretion. Long-continued use of a pessary is almost invariably followed by the appearance of a more or less purulent secretion, and this is usually destructive to the spermatozoa.¹ For this reason the secretions should be examined at short intervals during any use of a pessary in cases of sterility, and, as a rule, if the pessary is not promptly successful a suspension operation is indicated. It should include a deep curetage of the cervix, a light curetage of the uterine cavity, in most cases a division of the anterior attachments of the cervix (Chapter XIX), and suspension of the uterus by any means which the operator chooses. In such cases the ovaries will almost invariably be distended and should receive the appropriate operative treatment (Chapter XIX).

UTERINE FIBROIDS

The relation of uterine fibroids to fertility and sterility is determined chiefly by their situation, whether submucous, interstitial, or subperitoneal, though it is somewhat influenced by their size, number, and duration.

Submucous fibroids necessarily project into the cavity of the uterus, and not only always cause congestion, but usually interfere with uterine drainage, and by both

¹ There are exceptions to this rule in which the secretions remain normal and the patients become pregnant readily in spite of long-standing, non-adherent, backward displacements, but these cases will not consult the physician for sterility.

these factors habitually so alter the secretions as to prevent pregnancy.¹

Interstitial fibroids, lying as they do within the thickness of the wall and creating pressure throughout that portion of the organ in which they lie, not infrequently so far interfere with the circulation of the uterus as to cause congestion in degree sufficient to alter the secretions and thus initiate sterility.

True subperitoneal fibroids, projecting from the outer wall of the uterus, rarely interfere with impregnation.

It will be noted that these descriptions apply to single fibroids only, and they are so given for the sake of simplicity, but in the majority of cases a uterus which contains one fibroid contains several; and the greater the number of fibroids, the more likely it is that some one of them will be so situated that it will interfere with fertility.

There is, moreover, another way in which fibroids frequently interfere with fertility. Either as the result of the congestion caused by their presence, or possibly of the cachexia which is a characteristic accompaniment of most fibroids of any size, their presence is very frequently accompanied by one of the functional derangements of the ovaries which have been described in Chapter III, p. 56, and here, again, the change is more likely to be coexistent with submucous or interstitial fibroids than with those which are situated subperitoneally.

In cases of sterility in which the examination demon-

¹ The occasional exceptions to this rule usually occur while the fibroid is small and situated high in the uterus, but even then a satisfactory nidation is rare, and miscarriage is the usual result of an impregnation.

strates the presence of fibroids they may usually be regarded as the originating cause of the sterility. The considerations given above make it evident that the removal of the fibroids should be preceded by careful study of the mechanism of fertility, and that any operation which does not include the relief of the secondary conditions, which directly produce the sterility, is likely to be a failure in that respect.

It is true that the complete removal of all fibroids by myomectomy by an operator who does not appreciate the importance of the minor alterations in the ovaries may no doubt in some cases be followed by the spontaneous recovery of functional disorders of the ovaries which were originated by the presence of the fibroid. Too often, however, these conditions in the ovaries have become self-continuing, and such cases then require for the relief of their sterility a second operation, which might have been avoided by a few minutes of additional work at the first operation. Again, cases occur in which the presence of one or more intramural or subperitoneal fibroids of considerable size is readily apparent, but in which the sterility is, in fact, due to a small submucous fibroid, or to hypertrophy, or other changes in the uterine mucous membrane which are likely to escape observation. For this reason as well the operation is only too likely to be a failure unless the secretions have been carefully studied, and it may, therefore, be laid down as a rule that all myomectomies for the relief of sterility should be preceded by the full sterility examina-

tion, and accompanied by treatment of any secondary conditions at the same sitting.

Many cases are seen in which removal of the fibroids is indicated from the point of view of the patient's health and future safety, and in which the simplest and safest operation would be a complete removal of the uterus. The choice between this operation and the removal of the fibroids only by myomectomy is well understood by the profession from the point of view of the patient's other interests, but where the situation is complicated by an active desire for children, and the other interests of the patient seem to the surgeon to indicate a complete removal on account of the added risks of myomectomy, it seems to us that the condition should be fully explained to the couple concerned, and the choice between the operations should then be left to their decision. We have had reason to believe that the general surgeon does not always appreciate that myomectomy can be applied under such conditions to extremely complicated cases of fibroids, nor the fact that it may well leave a thoroughly useful uterus.

We may quote an illustrative case from our own practice. The patient was first seen in 1904, when two years married without a pregnancy. An interstitial fibroid which proved to be of the size of a small marble was easily detected in the anterior wall of the uterus, evidently below the peritoneal reflection. It was removed by vaginal myomectomy. This operation was followed by two children and one miscarriage, shortly

after which latter, in 1908, she was sent back by her physician with the statement that he had detected multiple fibroids in each pregnancy, and believed the miscarriage to have been due to their presence. On examination the uterus was found much enlarged and numerous fibroids recognized. She was advised that further full-term pregnancies were unlikely in this condition and would, moreover, involve considerable risk, and that hysterectomy was the surgical indication, myomectomy being considered for her case a much more dangerous operation. For religious reasons she declined both hysterectomy and the prevention of pregnancy. After full consideration she and her husband demanded myomectomy, although again advised that it would be attended by severe added risk. The uterus proved to contain twenty-six fibroids ranging from the size of an English walnut downward to mere seedlings, and scattered almost everywhere through the uterus. The operation was, of course, prolonged and difficult, but was again followed by two children and a miscarriage. When she was seen three months after the latter the uterus was of the size of the fist and again studded with fibroids. She was now forty-three years old, and in view of the unlikelihood of further pregnancies she consented to a hysterectomy, which was accordingly done.

Early carcinoma of the uterus does not always preclude pregnancy, but since such pregnancies rarely go to term and the gravity of the disease far outweighs the chances of the fetus, it needs no further mention here.

OVARIAN NEOPLASMS

The several neoplasms of the pelvic organs, like the displacements, cause sterility in some patients and not in others. The explanation is to be found in the occurrence, or non-occurrence, of disturbances in the mechanism of fertility as a consequence of the presence of the individual neoplasm.

Ovarian cysts are pathologic entities which differ, even when small, from the largest persistent follicle, in the possession of a much more organized cyst wall, which becomes progressively more differentiated as the cyst enlarges. They always protrude from the ovarian surface and as they grow larger tend to flatten the remainder of the ovary out against the bottom of the cyst. The largest cysts will sometimes have an abundance of ovarian tissue at their base, even though it is so extended and thinned by traction as not to be apparent during the persistence of the cyst.

In women who are desirous of children with innocent ovarian neoplasms the thickened tissue which is always present in the cyst wall at its base should invariably be dissected off from the tumor. After the first incision this can usually be done with the handle of the scalpel, and this process not infrequently results in the appearance of a normal ovary of fair size even when no such tissue has seemed possible at the beginning of the dissection. Any distention of the other ovary and any other abdominal conditions which are related to the mechanism of sterility should then be treated.

In sterility cases the presence of ovarian neoplasms should never lead to any neglect of the complicating conditions. The full sterility examination should be carried out, and if the altered secretional conditions which are usually present indicate any operative vaginal work this should always be done as a preliminary to the removal of the neoplasm.

A simple ovarian cyst of one ovary, even of large size, may sometimes be coexistent with an entirely normal ovary on the other side, and such cases are usually in a fertile condition, but in the majority of cases the other ovary will be found distended by retained follicles or corpora, and such cases will be sterile.

Another class of ovarian tumors are believed to be of luteal origin. These neoplasms may be either solid or cystic. When small they may contain evident traces of their luteal origin, but with increased size these become less evident. When these tumors are cystic the contained fluid is always somewhat sanguineous. In these cases normalcy of the other ovary is rare and they are consequently usually sterile.

Malignant degeneration of the ovary is a rare condition except in long-neglected cases. If present it must, of course, be treated by radical operation, but it will hardly be seen in cases which consult the physician for sterility only.

Ovarian dermoids are sometimes unilateral, but are often present in both ovaries. They show a certain tendency to recurrence, but except when long neglected

are not malignant, and in sterility cases should be given the same treatment as the other ovarian neoplasms, in all of which every effort should be made to remove the tumor without injuring the remainder of the ovary.

An attempt to include in this chapter every possible lesion of the genital organs would expand the work into a text-book of gynecology, and to a size entirely beyond our purpose, but it is hoped that enough has been said to enable the intelligent practitioner to grasp the general principles by which he should be guided in his management of the less common lesions when sterility is the indication for their treatment. In all such cases the use of the full sterility examination as a preliminary to any decision about treatment should be an invariable rule, since the detection and treatment of the disturbances in the mechanism of fertility is usually of equal importance with the removal of their determining cause. Neglect of this fact is the most common of all causes of non-success in the treatment of sterility.

SECTION III

THE DETERMINING CAUSES OF
STERILITY IN THE MALE

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CHAPTER VIII

INTRODUCTION

THE following chapters will consider the causes of the failure of the mechanism of fertility as they may occur in the male. Inasmuch as this is primarily a discussion of fertility and its changes, the description will center about that, and many points and details may be barely mentioned or even omitted that would be more important if considered from the standpoint of health. For such facts some good book on genito-urinary surgery should be consulted. The text will follow in a general way the course taken by the male cell, the spermatozoön, from its origin to its exit from the body, and will discuss the nature of the various obstacles, both mechanical and chemical, that it may encounter. If in outlining this in the Introduction there is some repetition of what has already been stated (Chapter III) it is necessary both for emphasis and for clearness.

In the male the essential organ of sex is the testicle. This organ has two functions, and for that reason produces two different secretions: the internal secretion, so called because it passes directly into the blood and is never seen as such, is produced by the interstitial cells, and governs to a large extent the development of the individual as a male; the other secretion is formed by the epithelial cells, and contains the spermatozoa which are formed by their maturation division (Chapter III,

p. 40 and Chapter XV, p. 183), and passes into the ducts of the epididymis (Fig. 2, p. 36). Failure of the internal secretion is usually associated with disturbance of other internal secretions, especially of the pituitary, and results in the feminine type of man. The rarity with which this is seen emphasizes the almost universal activity of the interstitial cells and their resistance to unfavorable conditions. The spermatogenic function which determines the ability of the individual to reproduce his kind is, on the other hand, very easily interfered with by a variety of causes. With the possible exception of certain of the cortical cells in the brain, the spermatogenic cells of the testicle are the most easily influenced by adverse conditions of any cells of the whole body. Anything that lowers the general condition of the individual or anything that tends to injure the testicle in any way may result in damaged spermatozoa. This shows first in a marked diminution of numbers and activity. The change in any individual spermatozoön may not be recognizable when examined under the microscope, but it seems probable that not only the fewer numbers but also a lowered vitality may have something to do with the resulting sterility.

After the spermatozoön is mature there is still a long road for it to travel before it can reach its goal, both in its host and in the genital tract of the female, and many and varied are the conditions which may interfere with it on its way. When all of the possibilities to the spermatozoön are realized, it seems less surprising that an

ejaculation contains normally a great multitude of active individuals, and that often many such emissions have to be placed in the female genital tract before pregnancy results. The actual number of spermatozoa in an ejaculation probably varies greatly under various conditions not only in different but even in the same individual; it has been estimated as high as many millions.

Aside from conditions in the testicles there are two factors which may prevent perfect spermatozoa from leaving the host as such: first, mechanical obstruction in the passages, or, second, changes in the secretions of the accessory glands so that they are biochemically hostile to the spermatozoa. Each spermatozoön has to travel about 20 to 25 feet between the testicle and its exit from the body. The greater part of this distance is traveled in the minute tubules of the epididymis, and here any inflammatory process may result in so much damage that the further passage of the cells is entirely blocked. The two important accessory glands are the prostate and seminal vesicles. These are situated in the pelvis just below the neck of the bladder. Under normal conditions they each form a secretion which makes up part of the semen. When either or both, as a result of disease or even from chronic passive congestion, show a change in the character of the secretion, it may result in a fluid hostile to the spermatozoa.

What are the methods of study in the male which will give the information necessary for the most accurate estimate of his degree of fertility or sterility? The one

most important thing is a study of semen from a condom specimen. In order to get the greatest amount of information from this specimen it is obtained as follows: after intercourse where the male has worn a condom, this is removed and the opening closed tightly and the condom is placed in a pint jar of water at body temperature well wrapped in paper to hold the heat, or, better still, in a thermos bottle of water at body temperature. This should be taken for examination at once and should be looked over within three hours at the outside, and preferably within two. The reaction to litmus and the gross amount of mucus are the first things noted. Then the microscopic study will show the presence or absence of pus, of amyloid bodies, and of hyaline bodies. It will show the presence or absence of spermatozoa. If present, the approximate number as compared with normal, the degree of motility, the shape and size, and lastly, the vitality as roughly measured by the duration of motility, are all of great importance. The proportion of normal and deformed spermatozoa measures in a crude way the amount of damage. Normally, semen is a mixture of the secretion from the testicle, seminal vesicles, prostate, and Cowper's glands. It is a white or very slightly yellowish, milky secretion, slightly alkaline in reaction. It is made up, under the microscope, of spermatozoa, a few cells, occasionally a few amyloid or starch bodies, and a few hyaline bodies. In it these spermatozoa retain their vitality for a long time if kept at body temperature, and move about without trouble. The most

frequent abnormal element found is an increase in amount and tenacity of the mucus. This mechanically interferes with the motion of the spermatozoa and may also change the reaction somewhat. Mucus is evidence of a congestive or irritative or a low-grade inflammatory process in the prostate, or, more often, in the seminal vesicles. It acts in two ways: first by entangling the spermatozoa and limiting motion and also by changing the nature of the secretions so that they are biochemically hostile to the living cells. To distinguish between prostatic and vesicular origin is often difficult, but generally where it is from the vesicles the condom specimen will show much mucus, while the expressed secretions following massage will show very little that is abnormal. Also a condom specimen taken after several days abstinence from coitus will show mucus, while a similar specimen without such abstinence will show much less mucus, or even none at all. The next important thing is the presence of pus. This may be very small in amount, or in bad inflammatory conditions may be very profuse. It comes from either prostate or seminal vesicles, or both, and is evidence of a change in the secretions which is hostile to the life of the spermatozoa. The amount of hostility apparently varies a great deal regardless of the actual amount of pus. For instance, one individual with relatively little pus may at first be sterile, and later, after treatment, which only slightly changes the amount of pus, become fertile, while another case with much pus at first and very little after-treatment

may show no change in sterility, and a third may be fertile with a moderate amount of pus known to be present in his prostate. In view of the fact that this is only one of many factors which influence the result, it is impossible to state accurately how important the presence of pus may be in any case; but there is a strong suggestion that it is not the pus itself which is harmful, but that pus is merely the evidence of an inflammatory process which may render the secretions extremely hostile to the spermatozoa. Under certain conditions not well understood the semen is filled with starch bodies and less often with hyaline bodies. When persistent, these are always evidence of serious interference with fertility. Very rarely small amounts of blood may be present, and this points toward inflammatory changes in the seminal vesicles.

Following the recognition of the abnormal elements, the study of the spermatozoa themselves will yield valuable information. Several things should be studied. First the relative number and motility. This can be told with considerable accuracy after a little experience. The type and duration of motility is important: whether there is vigorous motion with progress, or whether the motion is accompanied by little progress due either to entanglement in mucus or to deformity of the cells. The duration of life measures roughly the vitality; it can be studied equally well by putting a drop on a slide under the microscope without any attempt at artificial heat, or by keeping the whole specimen in an incubator

at body temperature and examining a drop from time to time. The proportion of normal spermatozoa and dead and deformed ones can be very accurately estimated by counting a few fields. Various types of deformity are met with, the reasons for which are not well understood, but it is enough for our purposes to recognize that they indicate in most if not all cases the presence of a hostile prostatic and vesicular secretion. These various changes in the semen will point toward the conditions which must be more carefully studied in the patient, and the examination of the patient is the next step. This examination will be influenced by the findings in the semen.

If spermatozoa are absent or few in number, previous disease of or trauma to the testicles may have caused so much damage that the spermatogenic function is almost or entirely lost, and examination of the testicles will show organs which are smaller and more flabby than normal. Or it may be that no change in size and consistency can be noted, and then only the history of a previous double epididymitis will give the clue to a complete obstruction in the vas of inflammatory origin. If none of these conditions exist, then a cystoscopy must be done and the deep urethra carefully studied. In rare cases the normal opening of the ejaculatory duct into the deep urethra is closed, probably as a result of a congenital defect. Because of the pressure in the duct behind the closure it balloons out and shows as a cyst projecting into the urethra. The cystoscopy at the same time establishes the absence of any stricture. If the

study of the semen shows the presence of spermatozoa, but with deformity or absence of motility, then the source of trouble is generally in the prostate and seminal vesicles,¹ and they should receive special attention. It sometimes happens that microscopic examination of a given sample of expressed prostatic secretion will seem almost or quite normal. Unless this is in line with the facts learned from the study of the semen the one examination should not be considered conclusive, and another examination after a period of abstinence from coitus should be carried out.

After all of these tests have been made of the various organs of the individual, one of the most important parts of the study is still to be made, namely, the consideration of the individual himself, his habits, his work, his worries, his diet, and his general physical fitness as a breeding animal. In general, anything which tends to increase the health of the patient will increase his fertility, that is, he must put himself under the same conditions of life as he would were he training for an athletic event. A diet which contains a liberal protein allowance and is high in mineral content, especially calcium, is the one best adapted for this purpose. In many instances where a man who has been accustomed to hard physical work, as, for instance, one engaged in hard college athletics, suddenly changes to a sedentary life he may by that change cause a very marked lowering

¹ See also Chapter III. It seems probable that some deformities, *e. g.*, small heads, are of testicular origin, while others are due to immersion in poisonous secretions (E. R.).

of his fertility. Worry is likewise one of the most potent factors in this respect, either directly or by influencing the physical condition of the man.

As we review all of the things which enter into this question we are almost forced to the conclusion that the strain of civilization is gradually tending to sterilize the more "cultured" portions of the human race. Race suicide, so much talked against in certain quarters, is not entirely the lack of desire for children; it is often a lack of ability to reproduce because the strain of living has so sapped the energies and used up the strength of the individual that he or she has no vitality left for procreation. It is not the physical labor which does this damage, but the strain and mental worry of modern life.

Vacations, business worries, habits of daily life of the patient must all be considered carefully, and he must often be treated as breeding animals have to be treated to bring him back to the highest fertility.

If a patient really means business he must often for the time being change his habits so as to conform to those necessary to put him in best breeding condition. A complete change of work for the time being from the city to the country, from a sedentary indoor existence to an active outdoor life, with plenty of exercise, proper diet, and absence of worry, will often give marvelous results which nothing else in the line of treatment possibly can do. It is, of course, often impossible to make any such change as here indicated, and the patient must then carry out the next best thing, which will often pay surprisingly well when faithfully tried.

CHAPTER IX

DISEASES OF THE TESTICLE

ANY condition which affects the testicles and which, because of either inflammation or trauma, results in permanent damage, affects the production of spermatozoa, and in that way results either in absolute or partial sterility. The following causes have to be considered:

1. Mumps—which manifests itself not only in the parotid gland, but in one or both testicles.
2. Injury—severe enough to leave some permanent damage.
3. Repeated partial torsion of the cord.
4. Varicocele of sufficient size to interfere with the blood-supply.
5. Postoperative interference with blood-supply.
6. *x*-Ray damage.
7. Undescended testicles.
8. Some unknown cause, since we occasionally find azoöspemia without any damage that can be shown.

1. MUMPS

A fairly large percentage of all cases of mumps in young male adults may have an accompanying orchitis on one or both sides. The actual percentage has never been closely estimated, but it has been given as high as 20 per cent. of all of these cases, with bilateral damage in the majority of instances. This generally comes on at

any time during the acute stage of the disease with marked swelling and pain; and, as always in any trouble with the testicle, the spermatogenic cells are the ones first damaged. The interstitial cells retain their integrity in spite of much damage, but apparently it takes very little to stop the production of spermatozoa. It happens, of course, because of the pressure which develops as a result of the swelling within the more or less unyielding tunica albuginea, or covering of the testicle. The end-result after the inflammation has entirely subsided in a small, flabby testicle which has entirely lost its power of producing spermatozoa.

Treatment.—The best treatment is preventive, namely, that the patient shall remain quietly in bed until after the acute stages of the disease, and that a suspensory be worn for the first few days after sitting up. Should the testicle begin to show signs of trouble, the immediate use of rest, suspension, either with a suspensory or an athletic “jockey strap,” and an ice-bag may lessen the trouble. If the swelling is very marked, operation is to be considered. This consists in multiple punctures of the covering of the testicle to relieve tension. This will at least lessen the pain and stop the possibility of gangrene, but it is entirely problematic how far it will lessen the resulting atrophy and sterility.

2. TRAUMA

Every active male, at some stage in his career, has enough of a blow on the testicles to realize how little

it takes to cause severe pain, but the vast majority of these minor injuries have no further result than immediate discomfort. On the other hand, there are enough cases where an injury more severe than the average results in sufficient swelling and pain to incapacitate the individual for several days, and in a certain number of such cases, dependent, of course, both on the injury and the amount of swelling following, there is more or less permanent damage. It is perfectly possible for this to result in fewer spermatozoa or even in their complete absence.

3. REPEATED PARTIAL TORSION

In the normal individual the attachment of the testicle to the wall of the scrotum by means of the mesorchium is such that the gland is held in place without any possibility of twisting on itself. In certain cases, however, this attachment is either lacking entirely or so long that it allows undue motion of the testicle. As a result a twist of the testicle on its cord can take place. This may result in sudden strangulation, which is a condition usually severe enough to send the patient to a physician for immediate relief, and in a great many cases to cause the death of the testicle. In certain cases, however, a partial twist or a complete twist which untangles itself will result in enough interference with the blood-supply so that atrophy takes place. In many of these cases the inflammation started up by this damage will fix the testicle by inflammatory adhesions and the end-result is a useless organ. If the individual reports early

in the process it may be possible to untwist a complete torsion or to recognize the possibility of partial torsion from the story, and anchor the testicle so that no further damage can take place. Inasmuch as this condition is not common, the diagnosis is rarely made early enough to prevent damage.

4. VARICOCELE

Varicosity of the veins in the scrotum is a common condition in the adult male. It occurs practically always on the left side and is more common in the young unmarried man. It often is a source of distress to its possessor, but only rarely does it reach the condition where it demands any radical treatment. Occasionally, however, the stagnation in the veins is sufficient to interfere with the blood-supply of the testicle. This shows itself by a beginning change in consistency. The treatment, of course, is obvious—the removal of the varicose veins.

5. POSTOPERATIVE INTERFERENCE WITH THE BLOOD-SUPPLY

Following a clumsily performed operation for the radical cure of inguinal hernia there may be a considerable degree of swelling of the testicle due to interference with the blood-supply, and in occasional cases the flabbiness of the organ which later remains is strongly suggestive of enough damage to stop the production of spermatozoa.

6. *x*-RAY DAMAGE

A few years ago, before the nature of the Roentgen rays were well understood, practically all *x*-ray workers were sterile. Although today every precaution is taken to protect those dealing with the agent, it is still true that "familiarity breeds contempt," and many men who use *x*-ray machines have their spermatogenic function damaged or entirely destroyed.

7. UNDESCENDED TESTICLE

The testicle starts its development inside the abdomen, and in the majority of cases migrates into the scrotum during the last few months of intra-uterine life. In 10 to 15 per cent. of babies this migration has not been completed at the time of birth, but will be finished before the end of the first year, so that up to this age the position of the testicle need cause no concern, but after this time its absence from the scrotum should be considered abnormal. It may be arrested in its descent at any point, so that there may be complete retention in the abdomen, or its position may be anywhere along the inguinal canal. In fact, in certain rare cases it may leave the course of normal descent and appear as a so-called ectopic testicle.

In any organ thus abnormally placed spermatogenic function may be interfered with by the constant pressure and extra amount of trauma to which the testicle is subjected. The majority probably lose their spermatogenic function shortly after puberty, although there are cases on record where full function has been preserved

into adult life. Any attempt at replacing the testicles in the scrotum, although it may be successful from the point of view of lessening the frequency of blows and other forms of trauma, will rarely improve its functional ability and generally leave behind a small, partly atrophied testicle which may be partially active, but generally has an entirely absent spermatogenic function.

8. UNKNOWN CAUSE

There is likewise often observed a temporary flabbiness of the testicle which can only be explained on the basis of general condition, and which is improved with resulting improvement in spermatogenic function in direct proportion to the changed general condition. There are also a few unexplainable cases with an absence of spermatozoa. Some of these are perhaps explainable on the ground of congenital deficiency, but certainly not all. This is well shown by one case, a healthy young man, who had on one examination plenty of motile spermatozoa, and a year later a complete absence of spermatozoa, both in the semen and in the epididymis and testicle, as shown by operation, without any intervening illness or change of habits. As the cause of this rare condition is not known no treatment can be used intelligently.

CHAPTER X

DISEASES OF THE EPIDIDYMIS AND VAS DEFERENS

ALL of the conditions thus far described have reference to interference with the development of the spermatozoa themselves; the conditions to be described next have to do with mechanical interference in the passage of the spermatozoa from the testicle and epididymis, and with the damage done by biochemically hostile secretions from a diseased prostate or seminal vesicle.

The epididymis consists of a very small, much convoluted tubule resting as a separate body against the side of the testicle, having actual connection with it only where the vasa efferentia pass from the testicle to the epididymis. This small canal is, as has been stated, about 20 feet in actual length, and through it these spermatozoa have to pass first. It is the seat of inflammation much more often than the testicle itself. It is involved in a large percentage of cases of gonorrhea. It is often the seat of a tuberculous infection and occasionally damaged by the colon bacillus and possibly other germs. Rarely also we find the so-called "clam shell" epididymis as a result of syphilis.

GONORRHEAL EPIDIDYMITIS

It is impossible to estimate the frequency of this condition. It is very common and is a frequent cause of

sterility in the male. It occurs in from 20 to 30 per cent. of all cases of gonorrhea, and is the commonest of all the diseases which involve the scrotal contents. It generally starts on one side, although both sides may be involved at the same time. It tends to recur either on the same or the opposite side. From the point of view of sterility it acts by blocking the passage for spermatozoa so that they cannot get through from the epididymis to the prostate.

Treatment.—There is no prophylactic treatment except avoidance of infection, as the disease can spread to the epididymis under any conditions of rest or activity provided it once reaches the deep urethra. It is, however, true that, other things being equal, the quieter the patient keeps, the less danger there is of spreading the disease to the epididymis. The best treatment is to go to bed immediately, with the scrotum at rest and suspended, and with an ice-bag over the infected side. In severe cases operation will relieve pain almost immediately. There is no evidence, however, that it will lessen the possibility of later sterility.

After infection of the epididymis has occurred there is nothing to be done until it has been shown that a particular case shows azoöspemia. The only chance of restoration of function then consists in an attempt to anastomose the vas at a point beyond the obstruction, with an opening made into the epididymis itself, at a place where examination of the fluid at operation shows that spermatozoa are present. Even with this opera-

tion the possibility of cure is not very great, as no one has ever reported more than 1 case in 3 benefited, and generally not over 1 in 6 or 8 will be helped. It is well to do one side at a time, as it gives a little better chance than to do both at the same sitting.

TUBERCULOUS EPIDIDYMITIS

This disease is generally only one manifestation of a more generalized tuberculosis and always is serious because of that fact. This disease always starts as a unilateral process, but tends to spread to the other side even after removal of the diseased organ. It acts in producing sterility primarily because of the tuberculous prostatitis which is always present in greater or less degree. This damage to the prostate results in a condition so hostile to spermatozoa that even if the epididymitis is confined to one side, the normal spermatozoa coming from the other are unable to survive the damaging secretion of the prostate. Because of this the disease always sterilizes except in the very early stage. In the beginning it may be hard to differentiate between this type of infection, a gonorrheal infection, or one of the rarer infections, but as the disease progresses instead of quieting down, the swelling of the epididymitis increases, the vas itself becomes more thickened and beaded, the disease area tends to become adherent to the skin of the scrotum, and if left without treatment long enough, always breaks through and leaves a persistent discharging sinus. The testicle does not become involved until very late in the

disease, if at all, the tunica albuginea serving as an effective barrier.

Treatment.—Unless the disease is recognized and checked at the very outset it results in permanent sterility, for which there is no remedy; accordingly the treatment need not be discussed here, as it belongs to the province of the genito-urinary surgeon.

EPIDIDYMITIS DUE TO THE COLON BACILLUS

There is no means of estimating the frequency with which the epididymis is involved in infections other than the two just mentioned, but it certainly is true that trouble with the epididymis occurs as a result of infection by the colon bacillus and probably other organisms which are making trouble in the prostate at that time. It is very difficult to make a differential diagnosis early in the disease, but time will rule out tuberculosis, which is the most important disease from which it must be distinguished. So far as sterility is concerned, it does its damage by obstruction in the tubules, as in the gonorrheal type, so that a unilateral process will never sterilize and a bilateral may not. Here, as in the other types, the condition of the prostate may be, and generally is, a more important factor than the trouble in the epididymis.

Treatment.—This condition is seen in sterility cases only in the chronic stage where no treatment other than the use of a suspensory is necessary; when seen in the

acute stage rest, elevation of the scrotum, and ice are generally all that are needed.

SYPHILITIC EPIDIDYMITIS

This is only one manifestation of the general infection which is such a potent cause of sterility in both sexes as discussed in Chapter VI. It comes at a late stage in the disease when all active symptoms may have been latent for a long time, and when, for that reason, the patient may not think it necessary to mention the old infection. It rarely comes in question as the cause of sterility; nevertheless it must be considered when a differential diagnosis is to be made in diseases involving the scrotal contents. It shows itself as a hard, insensitive epididymis which is involved equally at all points and in its attachment to the testicle is shaped very much as a clam shell. The treatment is the treatment of the syphilis.

VAS DEFERENS

The vas deferens may become involved secondarily in any infection which has invaded the deep urethra, prostate, seminal vesicles, or epididymis, but the damage is never permanent so that it never results in sterility. The only exception to this rule is in tuberculosis, and by the time the vas is obstructed by the progress of this disease, the patient is already sterile because of the prostatitis which is always present. It occasionally happens during operations for inguinal hernia that the vas is cut. This is probably more common than is ever recognized,

as the distortion of the anatomy and difficulty of dissection in strangulated hernias, in encarcerated hernias, in recurrent hernias, and even in simple scrotal hernias, or where a truss has been present for years, is often enough to result in this accident.

CHAPTER XI

DISEASES OF THE PROSTATE AND SEMINAL VESICLES

ANATOMY AND PHYSIOLOGY

THE prostate is a gland at the neck of the bladder surrounding the first portion of the urethra on its floor and sides. It is about the size of a horse chestnut under normal conditions, and secretes a fluid which mingles with the contents of the seminal vesicles and the fluid from the testicle at the time of ejaculation. The function of the prostate is that of a sexual organ and is one of the important parts of the male sexual apparatus. It has two secretions: one an internal secretion, which is poorly understood at present, so that we cannot say just what it does or how important it is; and second, the more generally recognized fluid secretion, which mingles with that from the testes and seminal vesicles at the time of ejaculation and forms the bulk of the semen. It aids in vitalizing the spermatozoa and gives them for a short time at least a medium favorable for their activity. Because of the large amount of this fluid in an ejaculation it is easy to see that even a slight deviation from normal may influence the germ cells to a large degree. It is sufficient for our discussion to recognize, on the one hand, that the normal secretion is necessary for the full

vigor of the germ cells, and, on the other, that a slight change in character may result disastrously.

The seminal vesicles are two much convoluted, sac-like glands resting on the upper and lateral parts of the prostate and extending above it for a short distance. It was previously taught that the seminal vesicles acted as reservoirs for the semen, and no other function was recognized. Today many physiologists disregard this idea and believe that these are secreting glands entirely. Clinical evidence leads us to believe that the truth lies somewhere between the two. It seems probable that secretion is the more important function, but it certainly is true that in many cases massage of the vesicles will bring out a considerable number of spermatozoa. In most of these cases the expressed secretion appears like inspissated semen, and whether this fact means that spermatozoa enter the seminal vesicles only in slightly damaged cases is impossible to say.

Here, as in the prostate, slight abnormality in the secretion may be very damaging to the vitality of the germ cells. The vas on each side meets the duct from the seminal vesicles and forms the ejaculatory duct, which passes through the prostate and opens into the floor of the deep urethra through the utricle. The prostatic ducts, several in number, open separately near by.

DISEASES

Inflammation and congestion of the prostate and seminal vesicles constitute one of the commonest, if not

the commonest, causes of sterility in the male. Although in any given case the inflammatory process may be more active in one or the other of these two glands, for the practical purposes of diagnosis and treatment they involve the same process and will be discussed together.

The extension of a gonorrheal infection to the prostate occurs in the majority of cases. It then starts up a process which may last for a long time, either as a gonorrheal infection or more often as a postgonorrheal prostatitis, due to a secondary infection, either by the colon bacillus or some form of coccus. Whatever the organism, the damage done the fertility of the individual is brought about by the change in the nature of the secretions, so that they become hostile instead of helpful to the spermatozoa and cause either actual death or lowered vitality of the germ cells. It is, of course, true that sterility does not always result, probably because the majority of patients with a mild prostatitis, although undoubtedly having a certain lowered fertility, nevertheless are able to impregnate their wives because of the normal fertility of the female half of the mating. But it must be emphasized that a prostatitis of any degree, is always a source of some lowering of fertility, and as such is a potential source of a sterile mating.

SYMPTOMS AND DIAGNOSIS

There may be no symptoms suggesting the presence of a mild prostatitis, or, if it is more severe, the patient may complain of slight frequency of urination, a sense

of irritation somewhere in the pelvis or a sense of distress in the rectum—all of this hard to define, but becoming increasingly bothersome to the patient. It may also involve the disturbance of the sexual act where the deep urethra and the verumontanum are involved, resulting in premature ejaculation, sexual irritability, or even lowered sexual desire. General nervousness and other manifestations of toxic absorption are sometimes present, and occasionally “rheumatism” in various forms may be due to the infection in the prostate.

DIAGNOSIS FROM THE STANDPOINT OF STERILITY

There are two methods of recognizing the presence of trouble in the prostate: first and most important, the examination of a condom specimen, and second, the examination of the prostate by the *trained* finger together with the study of the expressed secretion under the microscope. The latter method alone is never enough to rule out surely any trouble, inasmuch as a single massage may fail to bring out evidence of trouble that is present, especially if the trouble is in the seminal vesicles, which are especially hard to empty at times. The comparison of the findings in the condom specimen and in the expressed secretion may help differentiate between the prostate and the vesicles as the chief source of trouble, *i. e.*, where the condom specimen contains much mucus and perhaps pus, while massage gets very little that is abnormal, the vesicles are generally the chief offenders. This differential sign can be still further aided by ex-

amining the prostate after a week's abstinence from intercourse, when the diseased vesicles are more apt to be palpable and tender and the expressed secretion may contain what was missed before.

To the experienced finger the rectal examination gives very important information. The inflamed prostate is somewhat swollen and has a non-elastic, so-called "boggy" feel. It may be uneven if one side is more involved than the other, and if the trouble is of long standing there are often small hard areas. As the finger is passed up to the top and side of the prostate an increased thickening and nodularity will often indicate the presence of diseased vesicles.

All of these cases which are studied for the cause of sterility are, of course, in a chronic stage of the disease, and it is unimportant what the particular organism is, provided it is not gonorrhea or tuberculosis, and these two can generally be ruled out at once because of the length of time that the sterility has existed without more definite symptoms. Inasmuch as the damage to the prostate and vesicles in these cases is the cause of the sterility, the restoration of the health of the organs is the means of restoring the fertility. The basis of treatment in these cases is massage of the prostate and vesicles, with instillation into or direct application to the deep urethra. Massage should be carefully done to include the vesicles. In the majority of cases it has its maximum effect at five- to seven-day intervals, but where the irritation of treatment is very slight every

three or four days may give the best results. If urethroscopy has shown a considerable amount of trouble in the prostatic urethra that should also receive special attention. Mild degrees of trouble, such as are shown by the moderate redness and slight irregularity of the prostatic urethra which are present in many of these cases, generally may be relieved by posterior instillation of 20 per cent. argyrol, 1 per cent. mercurochrome, or 2 to 5 drops of $\frac{1}{2}$ per cent. silver nitrate. If there is much redness and irregularity of surface, with edema or distortion of the verumonatum, the direct application of silver nitrate in increasing strengths up to 20 per cent. and the use of the Kohlman dilator in addition to massage may be needed to bring about improvement. Where the trouble has gone to the other extreme, and manifests itself as a very marked and obstinate prostatitis, the daily use of heat, either by direct application or by hot sitz-baths, often helps the circulation and hastens restoration. Although the treatment is tedious and often seems to be accomplishing little, it gives astonishingly good results in the majority of cases who persist in it.

POSTERIOR URETHRITIS

A complicating factor in prostatitis must be discussed at this point; chronic posterior urethritis is mentioned separately to emphasize the need of investigating the deep urethra where sterility is involved, because inflammatory changes of the verumontanum may result in slight changes in the nature of the sexual act sufficient

to turn the scale from fertility to sterility where it is and on the border line. It is always accompanied by a greater or less degree of prostatitis, so that the two conditions must always be considered together. Very little that is accurate, either in pathology or symptomatology, has ever been recognized or described concerning this condition. The only sure way of estimating the amount of damage is by endoscopic examination. The general picture is that of redness of the whole area in this region, changes in the normal contour, such as edema, small polypoid growths of the veru itself or other parts of the deep urethra. In old cases there may be scar-like contractions, and in aggravated cases occasionally small ulcers. The symptoms are likewise very indefinite. There may be evidence of urinary irritability, such as frequency or pain, and in many cases sexual irritability, such as disturbances of the orgasm or disturbances of erection and ejaculation; premature ejaculation especially is often present. The treatment consists in the use of sounds, of deep instillations, and direct applications to the damaged area. Treatment is generally followed by marked improvement.

CONGESTIVE PROSTATITIS

It seems wise to make a separate subject of this condition and in that way emphasize it rather than to leave it under the general term of "prostatitis." The name "congestive" is used rather than "non-specific," in order to still further emphasize the nature of the condition and

the need of recognizing it from the point of view of sterility, as it may be and, in fact, often is a condition which is present without causing enough trouble to send the individual to a doctor for treatment, and it is only when an investigation to find the cause of sterility is undertaken that signs are found pointing toward this change. In the majority of cases it is not a condition of great importance to health. In minor proportions it may be present in many individuals under certain conditions and disappear of its own accord when the basis for its existence has gone, or in certain cases it may persist and get worse and be recognized and treated by a physician as a non-specific prostatitis.

This abnormal condition starts, as the name indicates, by a congestion in the prostate without infection, and then, either because of the severity of the initial attack or the persistence of the causative factors, the congestion persists with the accompanying abnormality in secretion. This change in secretion is shown by the appearance under the microscope of small amounts of pus, occasionally red blood-cells, less often an abnormal production of the so-called starchy bodies. A gross examination of the semen will show that it is nearly always loaded with mucus, and in extreme cases the reaction itself may be changed so that it becomes neutral or even slightly acid. The clinical symptoms are very slight, if any, and generally are only brought out on cross examination. Minor degrees of frequency of irritation of urination occasionally are present, a slight sense of uneasiness in the

rectum or indefinitely placed in the pelvis. The sexual act itself is seldom interfered with, although patients will occasionally state that there is premature ejaculation. In these last cases the urethroscope will generally show an abnormal prostatic urethra. The causes of this condition are numerous. A previous infection of the prostate, generally a gonorrheal prostatitis, has been present in a certain percentage of the cases, and although it seems probable that a previously damaged prostate is more susceptible to this type of trouble, the presence of a large proportion of cases with no demonstrable history of past trouble makes this theory impossible of proof. This type of prostatitis can occur at any time during the stage of sexual activity, and anything which can cause irritation in the pelvis may be the starting-point of this condition. Horseback riding, long automobile trips, or other forms of physical activity which cause pelvic congestion may result in any degree of this trouble, dependent on the severity of the activity causing it. It may be the result of overuse of alcohol, and even the overindulgence in a lot of rich, highly spiced foods may affect a susceptible prostate. Abnormal sexual excitement itself is a frequent source of trouble. Overindulgence in sexual intercourse, ungratified sexual excitement, or, as one eminent urologist has been pleased to call it, "mental masturbation," frequently make trouble. During married life coitus interruptus frequently results in a greater or less degree of this type of trouble. The diagnosis is made by the detection of abnormal elements

during the examination of either a condom specimen or of the expressed secretion after massage of the prostate.

Treatment.—The treatment of this condition is the same as the treatment of any chronic prostatitis: the regular use of massage, instillation, and sounds. When the vesicles are more involved than the prostate, it is more difficult to relieve the condition by massage, but, as stated under the treatment of chronic prostatitis, the result of faithful persistence in treatment may accomplish a great deal.

A few conditions not easily classified may most conveniently be described here.

CYSTS OF THE DEEP URETHRA

An occasional cause of absence of spermatozoa may be a congenital obstruction of the ejaculatory duct, as it opens into the urethra. Because of pressure exerted on the obstruction from within the duct there often results a cystic condition of the deep urethra over the duct which may be large enough to cause urinary obstruction as well as obstruction to the spermatozoa. By removing the cyst it is possible to cure both the urinary obstruction and the blocking of the duct. This can be accomplished very easily by burning off the cyst with the high-frequency fulguration, but this may leave behind a scar which, in turn, acts as a complete obstruction to the outlet of the spermatozoa. Operation, with the cureting away of the cyst, may likewise fail to open the ejaculatory duct, although any of these forms of treatment will

remove the urinary obstruction and may open the duct. Luckily this is a very rare condition and we do not often have to face this uncertainty of treatment.

STRICTURE

As a rule this condition will be met and treated by surgical means because of symptoms pointing directly to it rather than be seen first when the patient is being examined for relief of sterility, but occasionally a stricture which has not yet become small enough to send a phlegmatic individual for relief of urinary symptoms, may be bad enough to be the cause of sterility. The result is brought about in two ways, the first and least often seen is due to the mechanical obstruction caused by the presence of the stricture. If the scar is tight enough, forceful emission is absent and the semen may either be thrown back into the bladder entirely or slowly dribble away after completion of the sexual act. The treatment for this type is obvious. It is less often remembered, however, that behind every stricture exists a greater or less degree of prostatitis, and this can make trouble in the ways already discussed, so that it is not enough to dilate a stricture to the point where it ceases to be a menace to the urinary tract, but in order to secure the maximum results in cases of sterility the prostate itself must be treated.

HYPOSPADIA

If hypospadias is of any degree beyond the balanic type it is practically always seen and treated by urolo-

gists before it ever comes in question as a possible cause of sterility. Consequently, any description of the more marked types will be omitted. When it is of the balanic type it may occasionally be the cause of sterility because of the inability of the male to place spermatozoa where they can go forward and meet the ovum. In these cases there is often some other factor influencing the fertility or some other mechanical condition making intromission incomplete. In those cases where this happens, and where operation cannot help, there is no one thing which will be sure to overcome the difficulty. A condom with one or two small holes in the tip has been used successfully in at least one of these cases as a means of draining the semen forward into the vagina instead of allowing it to escape outside. This condition likewise, though not uncommon, seldom has to be considered as a cause of sterility.

CHAPTER XII

IMPOTENCE AND ALLIED CONDITIONS

INABILITY to accomplish the sexual act constitutes impotence. As the term is generally used it has reference to lack of ability to have satisfactory erection. From the standpoint of a discussion on sterility this section perhaps is the least important of any because nearly all of the conditions which will be spoken of are so obvious and so distressing to the individual that they have been recognized and treated for themselves and not because of the sterility which results. There are three main classes of conditions which bring this about. First, mechanical causes; second, changes in general condition, and third, the very indefinite condition of sexual neurasthenia.

MECHANICAL CAUSES

Under this heading come a variety of conditions not frequently seen, but none the less important when they occur. Ankylosis of the hips in certain positions as the result of old injury or disease occasionally makes trouble. Obesity, if accompanied by an abnormally small penis, may likewise render coitus impossible. Any hydrocele which gets beyond a certain point presents an insurmountable obstruction, as does a large scrotal hernia. A tumor of the penis or fibrosis of the corpora cavernosa may occasionally result in sufficient distortion to pre-

vent intercourse. In the same way an old inflammatory stricture with bending of penis in erection may make trouble. A tight frenum may pull the end of the penis over during an erection in the same way as a scar. The size of the penis itself at either extreme may in certain cases act as a relative cause of impotence.

GENERAL CONDITIONS

Any state of the individual which is attended with weakness or lowered vitality may have as one of the attendant symptoms inability to have erection. Following any long siege of sickness or under conditions where the individual has used up his vitality in doing prolonged labor, especially under conditions of mental strain, there often results temporary sexual weakness, and if the cause itself be prolonged the resulting impotence may become itself a source of worry. This is especially apt to occur in individuals who are naturally possessed of slight sexual appetite.

Drug habits may become the cause of impotence if carried beyond a certain point. Any injury or disease of the central nervous system which affects the lumbar segment of the spinal cord will affect the nerve centers controlling erection, and in that way result in complete impotence.

SEXUAL NEURASTHENIA

This is, in reality, a condition of the mind and not a condition of the body, although there is often an accompanying physical basis, generally easily remedied

when the mental end of the trouble is adjusted. It seldom occurs in individuals happily married, and for that reason is seldom to be considered as a cause of sterility. Abnormal sex habits, such as excessive masturbation, or coitus interruptus, may result in abnormalities in the deep urethra such as already spoken of, and may thus cause temporary trouble. One very prolific source of trouble is excessive sexual stimulation without gratification, or "mental masturbation." Occasionally from excessive nervousness or as a result of strong emotion temporary sexual indifference, or even a repulsion, may be present, but all of these conditions are the result of an abnormal mental attitude which has to be recognized before any efficient treatment can be carried out.

The remedy for the various things mentioned goes with the disease itself. Some of the mechanical causes mentioned can be cured, some cannot, and there is no remedy for any of them other than the obvious. Impotence from overwork, or disease, or drug habit can be cured by removal of the cause. The neurasthenic must be reassured and his irregular habits must be smoothed out. He is the most difficult type to handle and very often will fail to respond to anything at all.

SECTION IV

RELATIVE INFERTILITY, THE MARITAL
HABIT, AND THE PREVENTION
OF STERILITY

CHAPTER XIII

STERILITY OF THE MARRIAGE FROM RELATIVE INFERTILITY OF THE PARTNERS

IN the preceding sections we have been dealing with those sterile marriages which are dependent upon the sterility of one partner. We are now to consider those in which the failure of the union is due to a mere decrease of fertility on one, or more usually, both sides. Recent investigations have shown that such marriages are very common, and comprehension of their causes and treatment has greatly increased our resources in the management of sterility.

In this and the following chapter we shall deal with the general principles which govern relative infertility, and in succeeding chapters shall take up special instances. As this recent advance in knowledge was founded upon experimental work in the animal laboratories, and as the subject is both important and somewhat complex, we shall first state the general principles. We shall then give a brief résumé of the experimental work by which they were established for the domestic animals, and this will be followed by a short discussion of the clinical observations which warrant their extension to the human species. The next chapter will then be devoted to their practical use in the treatment of human marriages.

We believe that the following statements are now justified:

Certain not uncommon dietetic errors and some other depressing general constitutional conditions may decrease the fertility of some individuals to such a degree that their marriages become sterile and remain so while these conditions are allowed to persist.

A slight decrease in fertility from constitutional cause on the part of one partner to a marriage may so multiply a similar decrease in the other partner that their union is unproductive even though each of them is still fertile in the sense that either might have offspring if mated to a partner of high fertility.

These depressing constitutional conditions affect both sexes equally. The mechanism by which they produce infertility is by decreasing the activity of the testicles or ovaries until these organs fail to produce normal spermatozoa or ova.

The degree to which individual men or women resist these depressing influences upon their fertility varies widely. Thus in some individuals depression of fertility is one of the first effects of a defective diet or of the other depressing conditions which are to be spoken of. In other individuals, on the contrary, fertility is often maintained until the depressing condition is so extreme, or so long continued, that it produces serious depreciation of general health.

In most cases detection of the depressing condition which is present and its removal by alteration of the

habits of life, or by the appropriate general medical treatment, will result in the restoration of the affected individuals to their normal degree of fertility.

The application of these principles to the management of sterile human marriages has in our experience not only transferred a large number of cases which were formerly obscure to the hopeful class, but has also produced pregnancies in many cases which had been failures under the treatment which had been previously used. This is frequently true even of cases in which the primary treatment has properly and necessarily been operative. The importance of an assimilation of this recent advance in knowledge is then the reason for the recapitulation of the evidence upon which it rests, before proceeding to its practical application.

Though the dietetic work of McCollum,¹ Osborne and Mendel,² Robinson,³ and others was primarily directed to study of the ill health that results from malnutrition, it showed, incidentally, that the fertility of the animals which were used was frequently decreased even when the defects in their diet were so slight that they did not cause serious ill health. This fact suggested a set of experiments to be aimed directly at such infertilities.

A number of rats from a strain which had been care-

¹ McCollum, E. V., *The Newer Knowledge of Nutrition*, New York, Macmillan Co., 1918.

² Osborne and Mendel, *Jour. Biol. Chem.*, vol. xxxv, 1918; vol. xli, 1920. *Science*, xlv, 294, 1917. *Jour. Biol. Chem.*, vol. xxiii, 439, 1915; vol. xx, 351, 1915.

³ Robinson, Arthur, *Edinburgh Med. Jour.*, vol. xxvi, 137, 1921.

fully standardized for many generations by Dr. Helen D. King¹ were placed upon carefully calculated diets. One of these diets contained all the essential elements, to be detailed later, in full amount. Each of the others contained an unduly small supply of one of these elements, but was complete and sufficient in all other respects. These diets were planned to be physiologically similar to defective diets which are common among human beings, and in each the amount of deficiency was that which it was believed would be sufficient to decrease fertility without seriously depreciating the general health of the animal. All the diets were kept before them constantly in unlimited quantity.

The first step in the experiments was naturally, however, to establish the average fertility of the strain under the conditions of the individual laboratory. It proved that 65 per cent. of the matings made for this purpose produced young, and 35 per cent. were unproductive. The average mating fertility of these rats was then 0.65. Since the sterility of any of the unproductive matings might well have resulted from the union of one fertile and one sterile rat, it was evident that the next step should be to remate all the rats which had been concerned in unproductive matings with partners of proved fertility,² in order to determine which individuals were responsible for the infertilities of the first matings. When

¹ King, Helen D., *Jour. Exper. Zööl.*, vol. xxvi, 335, 1918; vol. xxvii, 1, 1919; vol. xxvii, 29, 1919.

² Rats which had been fertile in each of a long series of previous matings.

this was done it was found that there were many instances in which both the partners to a sterile mating had proved fertile when remated to another rat of proved fertility. Those which had been sterile in the second set of matings were then again remated to another rat of known fertility, and this process of remating was continued until, as it happened, every rat in this first short series produced young in one or another remating. This very surprising result proved that all the rats which had appeared to be sterile in the first series of matings possessed some fertility, although it evidently varied in degree in the several individuals. It was then apparent that the fertility or sterility of the mating and the degree of fertility of the individual partners must be considered as separate factors. It was further evident that an attempt must be made to determine the individual fertility of each rat in the entire series.

A full description of the prolonged and laborious series of experiments by which this was finally accomplished would occupy too much space for insertion here. Those who are sufficiently interested are referred to the original papers.¹

We must be content here with the simple statement

¹Reynolds and Macomber, Defective Diet as a Cause of Sterility, *Jour. Amer. Med. Assoc.*, July 16, 1921, vol. lxxvii, pp. 169-175.

Reynolds and Macomber, Certain Dietary Factors in the Causation of Sterility in Rats, *Amer. Jour. Obstet. and Gynec.*, vol. ii, No. 4, October, 1921

Macomber, Defective Diet as a Cause of Sterility, Final Report, *Jour. Amer. Med. Assoc.*, April 7, 1923, vol. lxxx, pp. 978-980.

Macomber, The Threshold of Fertility in Rats and its Relation to Diet Deficiency, *American Naturalist*. (In press.)

that by a long series of such rematings as have been described, first with rats of proved fertility, then with those of proved lesser fertility, it was possible to determine the degree of fertility of each individual with a degree of accuracy which proved to be sufficient for all our further purposes. This was accomplished by comparing results of all the matings of each rat under a system of trial and error, in which the result of each mating altered the status not only of that rat, but of all its partners, and successively of all their partners through the series. By each successive application of this principle the errors became less, and in the end the results were approximately accurate.

All the individual fertilities were expressed in percentages, and when they were all added together and divided by the number of rats concerned it was found that the average individual fertility was 0.82. On separating the records of the sexes it was also found that the average individual fertility of the males and females was the same—approximately 0.82. It will be remembered that the average mating fertility of the entire series was 0.65. On a mere inspection of these figures it was at once noticed that if the average individual fertility of the females was multiplied by the average individual fertility of the males the product would represent the average mating fertility of the whole series ($0.8 \times 0.8 = 0.64^1$), and this suggested that if the calculated in-

¹ Throughout this report we are avoiding the use of too great accuracy in percentages.

dividual fertilities of any two rats were multiplied together the product might prove to represent the fertility of their particular mating.

By way of testing out this possibility the fertilities of all the matings which had been made were calculated in this way. When the results were tabulated, as in Table 1,

TABLE 1
Schematic Chart of Fertility

Individual fertility.	Mating fertility, per cent.
1.0×1.0	1.00 or 100
0.9×0.9	0.81 or 81
0.8×0.8	0.64 or 64
0.7×0.7	0.49 or 49
Threshold for fertility.....	45
0.6×0.6	0.36 or 36
0.5×0.5	0.25 or 25
0.4×0.4	0.16 or 16
0.3×0.3	0.09 or 9
0.2×0.2	0.04 or 4
0.1×0.1	0.01 or 1

it proved that all the fertile matings had calculated percentages which were at or above 0.50, and that all the infertile matings had been calculated as below 0.45.

This justified a hope that it might be possible to establish a "threshold of fertility" above which fertility of the mating might be expected and below which it would not occur, but as the number of matings which had been made was not large enough to warrant a final conclusion to this effect, a larger series was undertaken. When this was concluded and all the results so far obtained were placed together, as in Table 2,

TABLE 2
Zones of Fertility

Individual fertility.	Matings.	Mating fertility.
1.00×1.00	Always fertile	1.00
0.9×1.00		0.90
0.9×0.9		0.81
0.8×0.9		0.72
0.8×0.8		0.64
0.7×0.8	Doubtful	0.56
0.7×0.7		0.49
0.5×0.9		0.45
0.7×0.6		0.42
0.6×0.6	Always sterile	0.36
0.8×0.4		0.32
0.5×0.5		0.25
0.8×0.2		0.16

it was seen that in this larger series there were a few sterile matings which had been placed somewhat above 0.50, and a few which were productive, although they had been calculated as just below 0.50. Although the exceptions were probably not more than would be explained under the limit of error in the method of estimating the individual fertilities, it was judged safest to abandon the theory of a threshold of fertility and to divide the table into the three zones of Table 2. The principle arrived at may probably be safely stated in the form that "A mating with a predicted fertility above 0.60 will be fertile, while one which is calculated as below 0.40 will be sterile, but that between 0.40 and 0.60 there is a doubtful zone in which either result may occur."

The predicted results were as true to those actually obtained, when the partners were of different fertilities, as when their fertilities were the same.

Thus,

.50 $\times$.70 = 0.35, and such a mating was always sterile,

but 1.00 $\times$.70 = 0.70, and such a mating was always fertile,

.40 $\times$.80 = 0.32, and such a mating was always sterile,

but .90 $\times$.80 = 0.72, and such a mating was always fertile,

.60 $\times$.60 = 0.36, and such a mating was always sterile,

but 1.00 $\times$.60 = 0.60, and such a mating was always fertile.

It follows, however, that if the individual fertility of any rat is below 0.40¹ that rat will have a sterile mating even though its partner is completely fertile, thus .35 $\times$ 1.00 = 0.35, and such a mating was always sterile.

The results were equally accurate whether the animal with the better percentage was male or female.

When the experiments were repeated with a longer series of rats which had been raised from birth, or long maintained, upon the defective diets, they afforded full and accurate proof that in rats such diets may decrease fertility without serious depreciation of health.²

These experiments also proved definitely that in rats a sterile mating may occur as the result of the union of two individuals of only moderately reduced fertility, and that both partners to such matings may be fertile when remated to a partner of high fertility. This fact had not previously been known.

They also showed that in rats the amount of reduc-

¹ It is, however, true that the fertility of any such rat can usually be raised by altering the conditions of its environment, and often to a degree which permits it to become a partner to a fertile mating.

² This had been shown as probable by the nutritional experiments quoted above. It was not only confirmed by the work detailed here and by some of the later work of Evans and Bishop (Evans, Herbert M., M. D., Bishop, Katherine S., M. D., *Jour. Amer. Med. Assoc.*, September, 1923, vol. lxxxi, No. 11, p. 389), but has since been established for several of the other domestic animals as well by the work of many of the agricultural experiment stations.

tion of fertility which is produced by such diets varies greatly in different individuals. This variation in individual susceptibility has since been proved to be of great importance in human infertilities.

As a further result of these experiments it became evident that we shall add greatly to the clearness of our conception of the whole subject of fertility if we cease to think of any mating or of any individual as necessarily either fertile or sterile, and realize instead that the fertility of either an individual or a mating may vary in any degree between full fertility and absolute sterility. This change of thought is of perhaps more practical importance than any other one factor in this recent great advance in knowledge of fertility.

These principles are now probably regarded as fully established for the domestic animals by those who have followed the results of experimental work in the animal laboratories and the agricultural experiment stations, and several years of careful clinical observation have now convinced us personally that they are equally applicable to the human race. Our reasons for this relief may now be set forth.

Innumerable clinical observations by the profession at large have fully proved that the normal and defective diets exert the same effects upon the *health* of men and women that the laboratory studies, which have been referred to, had established for the *health* of rats and other domestic animals. The occurrence during the last few years of many pregnancies from previously sterile mar-

riages among our patients, after a change of diet and without other treatment, points to the same conclusion about fertility. This result is, moreover, supported by certain of the more exact methods of observation which are possible in clinical work.

In human practice we can determine the physical state when the patient is first seen with far greater accuracy than is possible in laboratory animals; moreover, the symptomatology of present and past physical conditions which can be obtained from intelligent patients gives us a great advantage which we do not possess in work among the animals. Again, we can watch the improvements in physical condition under treatment by the use of methods of examination which have been worked out by the collective experience of the medical profession and which are far more elaborate and satisfactory than any which can be applied to the animals in the laboratories.¹ These advantages in human practice compensate us to a considerable degree for the loss of the remating methods which are possible in the laboratory. They, moreover, have added to our information a number of important points which could not be obtained in the animal work. Clinical observation has made it quite evident that the defective diets act in producing infertility through general and constitutional channels, and that the failure in the mechanism of fertility by

¹ Evans and Bishop have worked out certain methods of physical examination of the genital conditions in rats which have yielded facts of interest and value, but the results obtained are necessarily less complete than those which can be secured in clinical practice.

which these infertilities are produced is a complete or partial inactivity in the testicles or ovaries as a result of which these organs fail to produce or release effective spermatozoa or ova.¹

In the animal laboratories the study of depressing environmental conditions has been limited to the defective diets for the reason that the other similar conditions are less easily supplied under the conditions of laboratory work. Clinical observations conducted with the more perfect observations of constitutional condition which are rendered possible by the elaborate methods of observation which modern medicine has now made available have convinced us personally that some other changes in the environment are equally important.² Indeed, as our experience with these cases grows larger and our perception of the relation of such conditions to the degree of fertility has become more practical our personal belief in their importance has increased.

The chapter which follows this will be devoted to a detailed discussion of the defective diets which are met

¹ These infertilities of constitutional origin then differ from most of those which have been described in previous sections both in their causes and in the failures in the mechanism of fertility by which they are produced. In the latter the failures of mechanism have usually occurred during the progress of efficient gametes through the genital canals. In those now under consideration the canals may be thoroughly normal, but the failure is in the gametes themselves.

² The general trend of opinion in the laboratories and animal experiment stations, more especially the latest work of Evans and Bishop, and to some extent our own clinical observations, have raised the possibility that the depressing conditions other than the dietetic, which are to be spoken of later, exert their influence upon the ovaries and testicles through the production of defective assimilation of the dietetic elements, but this is as yet uncertain, and since the other conditions must at all events, in practical work, receive the special treatment which has long been generally settled upon as appropriate to them, they will be described in due course as separate affections.

with in human practice, and of the more frequent and important of the other depressing conditions which have been observed to depress fertility. The treatment of each of them will also be mentioned there in sequence and as they are taken up. Before entering upon this more detailed description of the subject it is, however, necessary to refer to one important complication which occurs with great frequency in practice, and which if it were not mentioned might lead to much confusion of thought. In the course of practice it will be found that the general conditions to which that chapter is devoted throughout its text, and the functionally inactive ovaries or testicles which are their consequence, are often accompanied, in one or another individual, by some one of the other failures in the mechanism of fertility, as a result of the presence of some localized determining cause as well. Such a cause will, of course, be accompanied by the abnormality in the genital canal which is its characteristic failure of mechanism. It is in the detection and management of such complicated cases that an extended experience and adroitness in the art of practice become especially valuable, but an attempt at description of all the many complications which may occur would render the chapter complicated and incomprehensible to any but the adepts who do not need it. Combinations of the results of the local disturbances which have previously been described with the facts about reduced fertility of constitutional origin must then be left to the practitioner to be studied out during his conduct of the case.

CHAPTER XIV

THEORY AND PRACTICE OF RELATIVE INFERTILITY IN HUMAN MARRIAGES

THE whole subject of the dietetic causes of infertility is so new that it has not yet been fully appreciated by the mass of the profession, and for that reason, in addition to that of its great importance to our subject, it may properly be prefaced by a few words upon the vitamin theory, or hypothesis, upon which it rests.

The old division of dietary elements into the stimulating proteins and the fuel-producing starches and fats is still of value and necessarily retained, but to this the new work has added another and all essential element, in its recognition of the importance of certain mineral salts and of the somewhat hypothetic substances which have been called the vitamins. This term is in itself somewhat unsatisfactory, and from the point of scientific completeness the whole vitamin theory is indeed provisional.

No vitamin has ever been isolated by chemical analysis, no man has ever seen or handled a vitamin. They are, in fact, strictly provisional substances whose chemical nature is not yet understood, but the articles of diet in which each of them occurs, and the extreme importance of their absence or presence in the diet of any individual, have been absolutely established by the visible ill effects which are produced upon animals from

whom any one of these hypothetical substances is withheld. It is also shown by their restoration to health or fertility when the withdrawn substance has been reintroduced into their diet. In short, the practical results which have followed the adoption of the vitamin hypothesis have been and are daily proving so brilliant and far reaching that no dietitian of today can do anything else than accept the vitamin hypothesis and speak of the vitamins as though they were as familiar and well known as sugar or salt, or any other visible and tangible dietary ingredients. Clinical experience has also made it more than plain that these substances are quite as important to the human race as to any other animal.

In addition to the vitamins we now recognize the importance to both growth and fertility of an abundant supply of calcium and phosphorus, and have learned too that these elements are not thoroughly effective when introduced as mineral salts, but should be contained in the diets and, therefore, in their natural organic combinations. The newer knowledge also recognizes the absolute importance of including in the diet certain essential substances which are well known to the chemists as the amino-acids. Some of these are present in all the proteins, but it has been discovered that to obtain a sufficient supply of all of them the proteins must be obtained from a varied diet, since very few individual proteins contain them all.

These various substances and their sources must now be described in detail for those who wish to thoroughly

understand the principles on which the dietaries to be recommended are composed, but these descriptions are necessarily somewhat lengthy and technical, and will be less important to those readers who only desire to obtain general principles.

There are at present three vitamins which are generally recognized as such: the fat-soluble or A vitamin, the water-soluble or B vitamin, and the antiscorbutic or C vitamin.

The fat-soluble A, as it is usually termed, is contained in sufficient quantities only in the following substances: butter, cream, eggs, the green parts of leafy vegetables and the parenchymatous organs of animals, such as the liver, kidneys, etc. It is not destroyed by moderately hot cooking. It is not contained in the starches and vegetable proteins which are the essential elements in the rest of our vegetable diet, nor in meat or the meat fats.

The fact that this vitamin is essential to all animal life explains certain habits of the carnivorous animals which have hitherto seemed mysterious. Field naturalists and hunters have observed that when the carnivora make a kill they first of all rip open the abdomen and devour the parenchymatous organs, after which they satisfy the remainder of their appetite upon the meat and fat. Since the parenchymatous organs of their kills constitute their only ordinary source of the fat-soluble A, their instinctive demand for this essential substance explains the fact that when game is plentiful they fre-

quently leave a large portion of the remainder of the meat unconsumed, and make a fresh kill when they are next hungry. In times of scarcity they are frequently seen to chew the buds and young leaves of the plants about them. Thus every one has seen the domestic dog chewing grass, an evidence of the fact that he is too often unprovided with a sufficient supply of the vitamin A. Again, it has long been known that the carnivora seldom breed in menageries, but since the promulgation of the newer knowledge of nutrition those menageries which have taken up the habit of feeding liver have begun to obtain young from their carnivora.

Complete or nearly complete deprivation of the fat-soluble A results in us, as in all animals, in severe malnutrition, even though all other elements of the diet are supplied in abundance; and also produces a peculiar form of ophthalmia. This was extremely common among children in Sweden during the early days of the late war, at which time the high price of milk in Germany led to too great an exportation of Swedish milk, and many little children were consequently totally without this all-important article. It was found in the hospitals that incipient cases of this blindness were promptly remedied by putting the children on a diet rich in whole milk and butter fat and without any other treatment. Complete deficiency of this vitamin is almost unknown among our population, but the minor degrees are extremely common, usually as a result of individual dietary whims; and moderate deficiencies in the fat-soluble A may produce

infertility among their earliest effects, often before any other evidences of malnutrition are present. This should never be forgotten in the treatment of sterility.

The water-soluble B is necessary only in extremely small quantities and is contained in fresh meat and whole grains, besides smaller amounts in milk and vegetables. From the fact that it is soluble in water and is not destroyed by heat it is almost never absent from a varied diet. Its absence produces the disease known as beriberi, which has never been prevalent in Europe or America, but has been seen in Labrador. It is removed from the grains by overmilling or the process known as polishing, and was formerly very common in the rice-eating countries, but since the recognition of its cause and the consequent substitution generally of unpolished rice it is no longer common even in the East.

The antiscorbutic vitamin C, the absence of which produces the disease which is known as scurvy, is abundant in citrous fruits and the fleshy vegetables (notably in potatoes and onions). It is present in fresh meat, but is destroyed by cooking or salting, hence we obtain it chiefly from fruits and from the raw onions and tomatoes which are sometimes used in salads. It is necessary only in minute quantity, and its complete absence is rare, but moderate deficiencies in this vitamin are not very uncommon.

A considerable number of mineral substances are essential elements in our diet, but most of them are needed in but small quantities and are present in much

of our food. Calcium and phosphorus in considerable quantity are, on the contrary, essential to growth, health, and fertility. The chief articles of diet which contain them in abundance are milk and eggs, but they are present in smaller percentages in most vegetables. This is one of the reasons why these substances are extremely important elements in nutrition.

The importance of an abundance of protein has long been recognized as essential to any successful diet. It is contained in all the grains and seeds which form the bulk of our vegetable diet and in all meats. It is not destroyed by cooking. It is never absent from our diet, but for fertility it is needed in rather large quantities and deficiencies sufficient to produce infertility are not uncommon. Our necessity for a supply of all the essential amino-acids by the use of a variety of proteins has been but newly recognized. It has been already referred to and will appear again a little later.

Starches and fats are the heat-producing elements in our diet. They are not absolutely essential to life and health. It is possible to live for long periods upon lean meat alone, but if an exclusively protein diet is to produce all the necessary heat, it must be consumed in such extreme quantity that it is both wasteful and trying to the digestion. In a properly balanced diet the starches and fats are contained in just such quantities as produce normal weight. It has long been well known that obesity frequently produces infertility, and it is equally true that extreme underweight has a similar result. Many women

reduce their weight to an extreme degree from a desire to preserve a girlish figure, and when such women are troubled by infertility they must be induced to eat an amount of the heat-producing elements in diet which is sufficient to bring their weight up to normal. Very fat men or women must be reduced in weight by a decrease of these elements.

Milk and eggs, which are designed by nature for the complete though temporary nourishment of young individuals, are perhaps the only substances which contain all the essential elements in due proportion and a reasonable quantity of both, or at least of one or the other, should be included in all diets. For reasons which are both physiologic and economic neither of them are, however, satisfactory as an exclusive diet for mature individuals.

All these considerations make it evident that he who is to treat sterility successfully must have a reasonable knowledge of dietary principles in their bearing upon infertility. This principle will be new to many, and the first impression made upon their minds will perhaps be that the dietary deficiencies must be most common among the ill-paid classes. This is, however, not the fact, as may be illustrated by reference to the diet of such peoples as the Chinese and East Indians, who live always upon a very restricted diet, and so far as the lower classes are concerned are always very close to the possibility of starvation. Evolutionary necessity and race instinct have, however, regulated the habits of such peoples to a

diet, which though unvaried and usually scanty, yet contains all the necessary elements in reasonable proportion. It is commonly said that some of these people live mainly upon rice, some upon millet, and some upon other grain, but all the grains contain the vegetable proteins, and upon inquiry it will be found that all of them eat some form of animal food and apparently in amounts which ordinarily supply the necessary quantities of all the essential amino-acids. All of them, too, use the milk products in some form, such as curds, cheese, or butter, and though the amounts are small they are taken daily and are, therefore, apparently sufficient to supply the fat-soluble A. The two other vitamins are contained in the vegetables and the grains, and the fact that the portions of such populations which are dependent upon the most restricted diets are always small and very light of bone probably much decreases the amounts of the mineral salts which are essential to them.

Similarly, though the less well-paid classes in Europe and America eat a diet which is economically restricted to a somewhat small range, necessity and custom have included in that diet all the essential articles, and the very fact that it is of necessity varied but little by taste and whim insures their consuming all the necessary elements from day to day and throughout their lives.

In the well-fed classes, on the other hand, an individual's choice of diet is governed chiefly by flavors, fancies, and theories. Many individuals "cannot take milk," many "dislike eggs," many "never eat salads,"

and omit spinach and the other greens. Further enumeration of such habitual mistakes is unnecessary, since instances will occur to every one. In the well-fed classes in particular a careful inquiry into the dietary habits of infertile individuals and a correction of any mistakes is very essential. Another variation of habit between the different classes of our population is also important, and may be mentioned briefly here in anticipation of what will be said immediately afterward. The abundant protein diet which has long been known to be favorable to fertility can rarely be assimilated without abundant muscular exercise. This is furnished to the ill-paid classes by their work, while the brain work of the better paid is often accompanied by an entire neglect of outdoor life and the use of the muscles. This leads us naturally to a consideration of the all-important subjects of poor assimilation and overwork.

Every one will at once assent to the statement that there is no advantage in putting a stimulating diet upon the table unless the patient eats it, but the equally true fact that there is no use in putting a stimulating diet into the mouth unless the patient is capable of assimilating it is too often overlooked. Animal breeders and trainers for athletic contests have long known that their charges cannot be brought into tiptop condition for their purposes by any diet unless they are also given a carefully regulated amount of exercise; and proper assimilation of a reasonable amount of the stimulating elements in the diet is always essential to fertility.

An exhaustive treatment upon metabolism and assimilation is not within the scope of this work, nor are its writers competent to write such a dissertation; cases in which there is evidently a vice of assimilation must be referred by most practitioners to authorities upon this subject, but when defective assimilation is dependent upon mental overwork and an absence of muscular exercise, its treatment is well within the province of the general practitioner. We have seen many instances in the human male in which either oligospermia, or reduced vitality of the spermatozoa, or both, have been remedied by the adoption of moderate daily outdoor exercise, evidently by an improved assimilation of an otherwise reasonably sufficient diet; and this is especially true of individuals who have dropped a previously well-established habit of exercise.

In the male both the defective condition when he is first seen and the reappearance of effective spermatozoa under treatment can be easily demonstrated by the microscope; in the female a direct microscopic determination of the condition of the ova is not possible, but our clinical experience has made it quite evident that defective assimilation from deficiency of exercise is not infrequent among women also.

The condition known as nervous overstrain, psychasthenia, etc., is closely allied to this subject. Every practitioner will recognize this in its connection with general health, but he is less certain to realize that in certain individuals nervous overstrain may produce

seriously reduced fertility as one of its first effects. It will rarely or never appear before some effect upon general condition has been produced, but it is often well marked before the patient shows any considerable signs of an impending breakdown. Individual susceptibility is here again of the greatest importance. Some heavily overworked individuals reproduce readily, while others of less satisfactory sexual development are likely to be infertile except at periods when they have relaxed in their work, and have put themselves into the best general condition.

The infertilities of constitutional origin which appear to be the result of defective diet or assimilation, etc., and with which we have just been concerned, vary from the class which are now to be spoken of, in that while those which have been described are merely the result of disturbed physiology, these others are the result of pathologic conditions.

In many individuals tuberculosis, anemia, and the auto-infections have a definite and pronounced effect in lowering fertility, and here again persons of low normal sexual development may show reduced ability for reproduction before their general health is at all seriously affected. In women, especially, even very slight degrees of anemia may be important. In both sexes such conditions as an overloaded colon, tonsillar retention, chronic alveolar abscess, cholecystitis, etc., may be enough to reduce fertility, and should therefore be searched for with the utmost care during the general examination in every case of sterility.

One further important subject must be briefly referred to. The evidence already produced by students of endocrinology makes it obvious that since the essential reproductive organs of both sexes, viz., the ovaries and testicles, are also glands having an internal secretion, and since the activities of all such glands are closely correlated together, alterations in other glands of this character may have a most important and far-reaching effect on testicular or ovarian activity, and hence on reproduction itself. For instance, it is a common observation to find non-ovulating ovaries associated with an enlargement of the thyroid gland, and scanty or absent menstruation and some aspermias are often associated with lack of activity of the pituitary.

At the present time this whole subject is still, however, in a controversial stage and no hard-and-fast conclusions can be drawn. For this reason the present fad of prescribing various combinations of extracts of the different glands of internal secretion in the treatment of infertility is to be deprecated. There seems to be no question that in certain well-selected cases there are certain of the extracts which may be of assistance in stimulating fertility, but there is also no question that a great deal of harm is done by their indiscriminate administration. At the present time we feel that any more definite statement as to the various indications would be unwise.

After all that has been said the methods of treatment which are necessary to raising a reduced fertility

should be easily apparent, but for clarity they may be briefly summarized here.

The diet which is most favorable to high fertility is one which contains a high percentage of animal proteins together with some slight excess of the vitamins and mineral salts. Milk is the most important single article, since it not only contains a fair percentage of easily digested protein but also forms the chief source, in our dietaries, of the lime salts. It is necessary to have a certain amount of red meat in the diet both because of its protein content and because it is our chief source of iron. This is particularly important for women. Butter and the leafy vegetables are very important as the chief sources of the fat-soluble vitamin. The water-soluble vitamin is supplied by the whole cereals and to a lesser extent by fresh meats and many vegetables as well as by the milk. Since we eat so little raw food the citrous fruits and raw tomatoes and onions should be used in reasonable quantity as the source of the antiscorbutic vitamin. The physician should in each case prescribe a diet suited to remedy the defects which he has found to be existent in the diet of an individual patient, and should remember that the elements which have been neglected should be for a time supplied in more than average quantity. The necessary detailed knowledge is well supplied in Dr. McCollum's book (see footnote on page 155).

The habits of the patients should be so altered as to supply the amount of muscular exercise which is neces-

sary to the assimilation of a stimulating diet, and to insure the mental and nervous rest which is essential to those who have been under an overstrain. Every physician is well aware that it is easier to recommend rest and exercise than to insure their adoption, but in cases of reduced fertility from such cause the attendant should make it plain to the patient that fertility will not be obtained unless these necessary changes of habit are made, and made in effective degree. A complete and prolonged change from the habits of civilized life and work to those of an out-door vacation is, of course, the best method, but when this is not possible, prolonged attention to these necessities in minor degree may often be effective. All the pathologic general conditions which depress health and fertility should be searched for and eliminated.

As an important corollary to this whole subject the physician should realize that in thoroughly normal conditions the first pregnancy occurs within at most a few months after marriage. He should also realize, as he too often does not, that in the absence of voluntary prevention failure of prompt impregnation always implies at least some slight abnormality in the condition of one or the other partner. When, therefore, the marriage of a couple who desire children is not followed by the appearance of pregnancy within a few months, it may be taken for granted that some decreased fertility in one or both partners is surely present. The physician should, moreover, appreciate that in such cases treatment instituted

as soon as the suspicion of sterility is excited is far more apt to be promptly successful than if it is undertaken at any later period. The advice "don't worry, but wait," which is so often given to those who are beginning to be anxious, is thoroughly bad advice, and would never be given by those who are experienced in the treatment of sterility.

That no surgery should be undertaken for the relief of a sterile marriage until the possibility of constitutionally reduced fertility has been fully investigated for both partners should need no emphasis, but since daily experience shows how often this principle is neglected it must be mentioned.

CHAPTER XV

MISCARRIAGES AND THE MANAGEMENT OF PREGNANCY

THE progress of knowledge within the last few years has established an adequate and satisfactory explanation of a fact which has long been a matter of common observation. This is that there are many cases in which considerable accidents or other physical causes fail to disturb pregnancy, and others in which the most extreme care fails to preserve it. It may fairly be said that we now know that the great majority of miscarriages are due to an imperfect conception. In these cases very slight exciting causes produce the miscarriage, while, on the other hand, if the conception is in all respects good and normal, miscarriage is unlikely to occur if even ordinary care is observed. This newer knowledge has been so recently obtained that it perhaps deserves to be set forth at some length.

For the sake of simplicity we shall here disregard the technical obstetric definition of miscarriage and shall include under this term all cases in which the fetus is lost before it is viable. We shall discuss the subject under three etiologic heads:

- I. Miscarriages due to imperfect fertility on the part of the father or mother, or both.
- II. Miscarriages due to imperfect attachment of the ovum to the mother.
- III. The influence of accidents or other trauma.

I

That the genetic condition of the father at the time of impregnation is as important to the fetus as that of the mother at the same time, and probably on the average more important than her subsequent condition and management during pregnancy, is at first sight a somewhat startling conception, but we now know that it is warranted by the facts. It should be noted, however, that this statement applies only to his genetic condition (*i. e.*, to the degree of his fertility) as established by his health conditions during many months before the conception of the fetus, and not to any temporary condition at or about the time of coitus. The principle upon which the whole matter depends is that a normal conception can only occur as a result of the union of a normal spermatozoa with a normal ovum. That the spermatozoön and ovum are of exactly equal importance to the development of the embryo has, however, only been fully realized in comparatively recent years and as the result of modern cytologic work. This work has been so specialized that many physicians are still practically unfamiliar with it, and a brief résumé of the facts which bear upon this particular point may not be out of place.

It is well known that the cells of each species in the animal kingdom contain a definite number of chromosomes (Figs. 11-13, pp. 184, 185), which number is distinctive of the species and varies between different species. It is important to realize that throughout life,

from the first segmentation of the ovum to the last which occurs in the old age of the individual, the chromosomes play an essential part in every cell division. They are the most essential factor in the transmission of heredity during fertilization and in the preservation of the characteristics of the individual throughout the subsequent segmentations. The first segmentation of the fertilized ovum differs, however, from all subsequent cell divisions in that it is preceded by the processes of maturation and fertilization.

The essential step in maturation is the process of reduction divisions by which the number of chromosomes in the nucleus of the matured ovum and in the spermatozoön are reduced to one-half the number which is characteristic of the species. The details of the reduction divisions vary in the two sexes, but the final result is the same. This difference may be summarized by saying that in the reduction divisions of the ovum one-half of its chromosomes are extruded and lost; while in the more complicated reduction divisions of the male extrusion does not take place, but the final result is the same, in that each of the matured spermatozoa contains only one-half of the full number of chromosomes.

As a result of the reduction divisions, then, neither the matured ovum nor the spermatozoön is a complete cell, and neither is capable of segmentation and the formation of a new individual without the aid of the other, but each is ready to play its part in the process of fertilization.

When these two bodies meet, the spermatozoön penetrates into the substance of the ovum, its tail disappears,

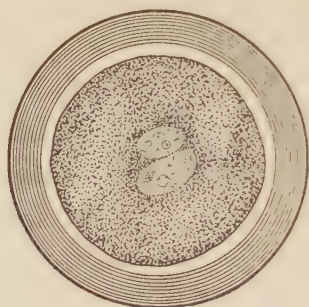


Fig. 10.—The male and female pronuclei.

and the head becomes the male pronucleus (Fig. 10), while the persistent half of the nucleus of the ovum acts



Fig. 11.—The male and female chromosomes are still in two distinct groups.



Fig. 12.—The two groups of chromosomes have mingled and are indistinguishable.

as the female pronucleus. The two pronuclei then approach each other and fuse to form the complete or cleavage nucleus of the fertilized ovum, which by their

union now contains the full number of chromosomes that is essential to segmentation.

With the appearance of the segmentation spindle in the first segmentation of the completed ovum the chromosomes of the male and female nuclei approach its equator in separate groups (Fig. 11), but shortly mingle and become indistinguishable from each other (Fig. 12).



Fig. 13.—Each chromosome has divided into two halves, the halves have separated and migrated toward the poles of the spindle in preparation for the segmentation of the cell, which will pass through the equator of the spindle.

Each chromosome then divides in half, the separated halves move toward the ends of the spindle (Fig. 13) and are divided from each other in the first cell division of the individual, which passes through the equator of the spindle.

Each daughter-cell then contains the normal number of chromosomes, one-half of which are derived from the

spermatozoön and carry with them the characteristics of the father, while the other half are derived from the ovum and carry the inheritance from the mother. Each is then complete by itself and capable of segmentation without extraneous aid. The embryo now consists of two complete cells, its individuality as a future human being of definite inheritance is fully established, and since its whole subsequent development is conducted by cell division of these two complete cells and their descendants, it is evident that its perfection depends as fully upon the quality of the spermatozoön as upon that of the ovum.

These cytologic observations are evidently in accord with the clinical condition which we have seen many times in the human race in which defective general condition in either partner has been attended by miscarriages, while after that partner has been put in good condition subsequent pregnancies have progressed normally.

The conception that miscarriage is usually a result of decreased fertility of a partner to the marriage moreover explains the fact, which has become very familiar to us in clinical work, that imperfect conceptions and consequent miscarriages are very apt to occur in the course of treatment of cases in which either partner is of lowered fertility. We have come to accept such miscarriages as partial successes and as an encouragement toward future results, *i. e.*, in cases of lowered fertility in which the degree of fertility of either partner has pre-

viously been so low that no conception at all has occurred, the appearance of an imperfect conception is good evidence that the fertility of the affected partner is improving, and that with a continuance of treatment we may confidently hope for a successful pregnancy.

We have, moreover, even in the human race, some evidence of definite scientific value. When in these cases the defect has been in the male, visible improvement in the number and motility of the spermatozoa has been also noted on microscopic examination. Again, studies of the specimens passed in human miscarriages which have been made during the last few years by many observers¹ have shown that in a very large proportion of all cases the fetus is imperfect, and that the miscarriage has consequently been due to its arrested development and death. Most such imperfections of the fetus are the result of imperfect or otherwise abnormal segmentation in the ovum, and since segmentation is governed equally by the chromosomes derived from the male and female pronuclei, it is evident that the genetic condition of the father at the time of the formation of the efficient spermatozoön which furnishes the male pronucleus, is as important to the fetus as that of the mother at the time of the formation of the ovum, and its pronucleus.

The condition long familiar to the profession under the title of "habitual miscarriage" is usually the result

¹Contributions to Embryology, Publications of the Carnegie Institution of Washington, Vol. XII (Streeter, Meyer, Mall, Corner, et. al.).

of a persistent low fertility in one or the other partner to the marriage. In fact, miscarriages due to any of the causes, general or local, which result in the death of the fetus, or its imperfect attachment to the uterus, tend to occur repeatedly so long as the causative condition is allowed to persist.

Individuality must also be allowed for in miscarriage as in all matters of relative fertility. Observations¹ on ferrets, rats, and less extensively on other pluriparous animals, have shown that in slightly lowered fertility the uterus often contains a proportion of blighted embryos interspersed among the normal ones. These and most of the occasional miscarriages in between normal pregnancies in the human race and other uniparous animals may be regarded as instances of conjugation by an individually imperfect gamete.

One as yet undetermined point may be mentioned before we leave this subject.

Cytologic research has also given us some information about imperfect segmentation. In a few instances failure in the processes of fertilization or of subsequent segmentation have actually been observed under the microscope,² and cytologic opinion tends to a belief that when either the ovum or spermatozoön is delayed more than a few days in the tube fertilization is apt to be imperfect, probably as a result of diminished vitality in the gamete

¹ Robinson, Arthur; *Edinburgh Med. Jour.*, 26, 137, March, 1921. Reynolds and Macomber: *Jour. Amer. Med. Assoc.*, July 16, 1921, vol. 77, pp. 169-175.

² Prentiss and Arey, *Text-book of Embryology*, Charles S. Minot, *Laboratory Text-book of Embryology*.

which has suffered the delay; but all cytologic research has been conducted on the lower animals, and on broader biologic grounds any transference of this belief to the human race seems unwarranted. There are among the mammal instances in which extremely long delay is normal. In the bats, for instance, an interval of four to five months normally intervenes between insemination and ovulation. It seems a safer statement to say that in the human race we have no exact knowledge of the length of time during which either the ovum or the spermatozoön may retain full vitality in the tube.

The treatment of these cases of infertility of constitutional origin is that which has been given in Chapter XIII.

II

FAILURES IN NIDATION

We may now proceed to a consideration of our second etiologic heading. We have seen that the genetic relations of the male and female to the fertilized ovum are precisely similar and of equal importance. The normality of the fertilized ovum, and, therefore, the subsequent normal development of the fetus, is, then, up to this point equally determined by the condition of each parent, but the share of the mother in the history of its subsequent development differs from that of the father in the fact that from the time of fertilization onward the embryo depends for its nourishment on its attachment to her uterus.

Certain local conditions, such as chronic congestion, endometritis, displacements, and uterine new growths (Chapters IV and VII), may prevent nidation, or render the attachments so far imperfect as to interfere with the development of the maternal portions of the decidua, and so cause the death of the fetus at some period in the course of pregnancy, when miscarriage, of course, follows. When chronic congestion is the result of general conditions, such as, for instance, incorrect marital habit, it may be in itself the only local abnormality, but it is also present as a result in the displacements and in some other less common conditions. Whenever chronic congestion is sufficiently severe to threaten miscarriage its presence will be evidenced by an increase in the symptoms which are commonly characteristic of pregnancy, such as nausea and sense of bearing down in the pelvis. In some such cases persistent vaginal glycerin depletion and treatment of any relievable cause thereof, as for instance, a displacement, may enable the pregnancy to proceed without interruption. In other cases of this class further miscarriages may be prevented by the appropriate treatment of the causative conditions which are present before pregnancy is again permitted to occur. Again, deep lacerations of the cervix may cause lack of support to the growing ovum and so permit separation from slight exciting causes. Finally, severe exhausting constitutional disease on the part of the mother, *e. g.*, diabetes or the grave anemias, may sometimes interfere with the nutrition of the normal fetus to a degree suffi-

cient to cause its failure and a consequent miscarriage.¹ In these cases treatment of the abnormal conditions during pregnancy is usually impossible, but the removal of the causes after the patient's recovery from miscarriage will usually enable a succeeding pregnancy to proceed to full term.

III

THE EFFECTS OF TRAUMA

Most miscarriages were formerly attributed to the effect of slight accidents to the mother or to some indiscretion in her conduct, but the advances in knowledge which we have described in the first part of this chapter have made it evident that trauma, in which we should include both accidents and overexertion, is a far less important cause of miscarriage than we then believed. It is, indeed, seldom a primary cause.

Nothing that has been said should, however, lead to neglect of ordinary care against overexertion and similar indiscretions during pregnancy. There is no doubt that lack of care occasionally results in a miscarriage even in thoroughly normal cases. Again, such a result may occur, not infrequently, in cases in which some slight abnormality has resulted in similarly slight defects in the attachment of an otherwise normal ovum, which with proper care might have perfected its attachment and gone on

¹ Miscarriages due to the infective diseases, such as syphilis, scarlatina, typhoid, etc., are, however, now believed to be due to actual transmission of the disease from the mother to the fetus. Miscarriage in this case also is then again due to the death of the fetus, which is little fitted to resist such infections.

to the birth of a normal child at term. Finally, although the large class of miscarriages which are due to genetic effects in the embryo are from their very nature inevitable and no loss, it is usually impossible to recognize them as imperfect fetations until after the miscarriage has occurred. For all these reasons care against the occurrence of accidents and overexertion should always be observed.

It is universally known that the menstrual flow is normally absent during pregnancy. It is not generally recognized that the physiologic impulse toward such a flow is usually present at intervals of twenty-eight days throughout pregnancy, and that pregnancy lasts normally for ten catamenial periods, so that although impregnation may occur at any time in the menstrual month, labor usually appears at or about two hundred and eighty days (ten catamenial months) after the last normal menstruation. Miscarriages occur most frequently at the time when the menstrual flow is due, and for this reason especial care should be taken for a few days at the time when menstruation would be due if the woman were not pregnant. In all women in general, and especially in women who are under treatment for sterility, the first menstruation which is missed should be regarded, in the clinical care of patients, as marking the first four weeks of a possible pregnancy.

Reasonable precautions should be followed throughout pregnancy; they should be increased for some weeks at the time of the third period, at which time the process

of formation of the placenta is most active, and at the end of the sixth month, at which time a rapid increase in the size of the fetus is appearing. Miscarriage is more likely at about these dates than at any other time after the first few weeks. The dates of recurrence of the catamenia should throughout be calculated as recurring every twenty-eight days, whatever the usual habit of the patients may be, since those women who are conscious of the molimena, or catamenial sensations, during pregnancy, almost invariably experience them at the twenty-eight-day date, even though their usual dates are at other intervals. Especial care should, moreover, always be taken at times when the molimena are perceptible. The reasonable care to which we have frequently referred consists in the avoidance of certain indiscretions which must now be detailed seriatim.

Pregnant women vary greatly for individual reasons as to the amount of exercise which is best for them in the intervals between the menstrual dates. In general, sufficient walking to maintain general well being is desirable, but several short walks daily are better than one long one, and they should not be rapid or hurried, or carried to the point of fatigue. Slow movement is seldom harmful, but running, jumping, or abrupt movements of any kind are risky. An illustrative case in our practice may be quoted here:

An exceptionally strong young woman was in excellent health and spirits when two and a half months advanced in her first pregnancy. She was living in the

country and walking freely several times daily. When on the lawn one afternoon a guest in the house threw a baseball sharply along the ground toward her. She side-stepped quickly, dropped on her heels to make the "pick up," caught the ball, threw it back, and went into the house. Her husband, following her, found her flooding severely. A physician who was called thought miscarriage inevitable, but after several weeks' rest in bed and much care during the succeeding six months the pregnancy was saved and resulted in a fine child at term. Athletics and abrupt motions of all kinds may disturb the most normal pregnancies.

Most pregnant women can do their housework if they will avoid the heavier exertions, such as lifting full coal-hods or pails of water, or turning heavy mattresses.

Blows on the abdomen, falls upon the back, or into a sitting posture may provoke miscarriage. Coitus should be prohibited at the menstrual epoch and should be gentle and only moderately frequent at other times. Undue restraint of the woman's desire if it is present, or any other causes of chronic congestion (Chapter XV) should be avoided.

Women in whom the motion of an automobile causes sensations of pelvic fatigue or discomfort should avoid its use, and no pregnant woman should take long or rough drives.

Efforts which put the abdomen on the stretch, such as reaching to a high shelf or hook, should be avoided from an early period in pregnancy.

Severe nervous shocks, such as sudden grief or other violent emotions, are sometimes followed by miscarriage, especially if they are in any way connected with the marital or maternal emotions. In evidence of the possible pelvic effects of emotion an unusual and extreme case may be quoted here:

A young woman who had had a succession of early miscarriages was referred to us for diagnosis of their cause. Both the patient and her husband appeared to be in the best of health, local and general, and no cause for the miscarriages was found, though it was noted that the patient was of a highly emotional and excitable temperament. Shortly afterward she reported herself as again pregnant, and in spite of a careful regimen she again miscarried at about seven weeks. The ovum appeared to be normal, and careful review of the events of the preceding days hour by hour showed nothing which would be regarded as causative. The patient, however, stated in the course of cross examination that this and the two preceding miscarriages had occurred a few hours after she had been to a concert, and on further questioning she said that she had always noticed that listening to certain types of music was usually followed by pelvic sensations (*i. e.*, acute uterine congestion). Unlikely as such an explanation seemed, she was cautioned to avoid music during any succeeding pregnancy, and in the next few years three successive pregnancies resulted in children at term.

Severe mental work should be avoided during preg-

nancy, and pregnant women should as far as possible lead uneventful, easy, normal lives.

A corset which supports the lower abdomen but permits free expansion upward is a comfort to most pregnant women, but any other form of corset should be abandoned early.

Most pregnant women do better if they eat between meals, *i. e.*, if they take six or seven small rather than three large meals. Constipation is a cause of pelvic congestion and therefore to be avoided, and most pregnant women find that they must use a mild cathartic daily in order to avoid it. The ingestion of large amounts of water is advisable and the diet should contain more calcium than is necessary at other times. The occurrence of dental caries, which was formerly believed to be almost inevitable during pregnancy, is now known to be due to the drain upon the mother's calcium content which is incurred during the formation of the bones of the child. The medicinal administration of calcium or, preferably, an increased amount of milk will supply this loss. The old adage of "a tooth for every pregnancy" need not then be feared.

Extra-uterine pregnancies are generally believed to be dependent for their occurrence upon minor abnormalities in the fallopian tubes. In an analysis of over 500 sterilities we found that treatment had been followed by extra-uterine pregnancy in five instances, in each of which, however, the operative removal of the

extra-uterine and the tube in which it occurred was followed by normal pregnancy later.

Habitual miscarriage is effectively a form of sterility. It is often dependent on decreased fertility of one or both partners (Chapter XIII), and is then usually easily remedied after the detection of its cause. All women should be warned that the results of any miscarriage should be carefully saved and submitted to expert embryologic examination.

CHAPTER XVI

ONE-CHILD STERILITY

THIS term is rather loosely employed to cover all cases of sterility in which there have been one or more previous full-term pregnancies, but since it is in established use in this sense it is perhaps as well to continue to use it.

The first and one of the most important points in this subject is that, in our experience, the sterility of the mating is in a considerable proportion (about 20 per cent.) of even these cases attributable to the male, and we shall treat first of these cases. It is indeed probable that the true percentage of male sterilities in these cases is much higher, since many of them in whom it is accompanied by decreased potency are likely to consult a genito-urinary surgeon, while only those in which the desire and potency of the male remain intact are likely to come to our attention. In the management of this class of sterilities it is of primary importance that the physician should free himself from the general impression that a man who is once fertile is always fertile. It is far from the fact.

The causes of trouble on the male side in these cases differ from those which have been already described as characterizing male infertility in general (Chapters VIII to XII) chiefly in the fact that absolute sterilities of the

congenital or conpubertal type are, of course, absent, but any of the other causes may always have appeared since the conception of the previous children. Cases of sterility or decreased fertility from the sequelæ of gonorrhea are less frequent, but those due to the congestions and minor infections (Chapter VI) have been present in our experience with about as much frequency as in the other sterilities. These patients, of course, average older than in the other sterilities, and it seems probable that the decreased frequency of congestion of the prostate from marital excess, etc., which belongs to this fact is offset by the increased liability to prostatic irritation which is common as middle life approaches.

Decreased fertility from the depressing systemic diseases, such as, for instance, diabetes, and from the effects of the auto-infections, such as those of chronic appendicitis, cholecystitis, etc., also occur more often as the average age of the patient increases, and are therefore rather more frequent in this class of sterilities.

Physiologically lowered fertility in the male (Chapter XIII) occurring without definite systemic disease is distinctly more frequent, probably because of the increased responsibilities and growing complexity of the business life of somewhat older men.

In general, it may be said of the one-child sterilities of male origin that they are prone to appear in cases in which the male is of rather low fertility constitutionally. The chronologic marital history is often very suggestive. With normal couples the first child after marriage is

usually conceived after from three to six months, or earlier, and then not infrequently in spite of the use at first of some preventive method. In many of these one-child sterilities the single conception that has taken place has occurred after one or two or more years of married life. They often give the history that it occurred after a vacation or when the male was in particularly good physical condition from one cause or another.

On local examination it is not infrequent to find the testicles small and lax, the latter often as a purely temporary condition, with a corresponding decrease in the numbers and vitality of the spermatozoa. The history too often shows an undue decrease of recent years in the amount of desire, which may even amount to temporary impotence at times when the patient is especially tired, although potency may have been entirely normal early in life.

The lesson to be drawn from these facts is that a full sterility examination of the male is fully as important in one-child sterility as in any other. The physician should never assume continued fertility from the fact that it has been demonstrated once.

In the one-child sterilities which are primarily due to trouble in the female, cases of developmental origin are absent, and even the cases of lowered fertility from underdevelopment practically disappear, because the changes incidental to pregnancy almost invariably complete the development of the female generative organs.

Infertilities due to the congestions, infections, dis-

placements, and neoplasms (Chapters IV to VII) become much more frequent as a result of the accidents and after-results of labor. The salpingites are increased in number by the infections of obstetric origin, and a new class of uterine and cervical congestions makes its appearance as the result of the subinvolutions and lacerations, and of the displacements of various degree due to relaxation of the pelvic supports. Cases in which suspended ovarian function is an element do not disappear, but are reduced in frequency about one-half, and those which are seen occur almost without exception in connection with long-continued chronic congestions, and probably as a consequence thereof. The accidental infections to which congested organs are always especially prone also increase correspondingly. In our experience these congestive cases constitute a large majority of the one-child sterilities of female origin.

Small fibroids which have been unimportant at the time of the first conception may have their relation to the uterus so far altered as to inhibit further pregnancies.

The diagnosis and treatment of these causes of sterility in the mating have been already discussed with the exception of those which are exclusively the results of labor, viz., the subinvolutions and lacerations. These are easily recognized by any competent gynecologist, their treatment is always operative, and is conducted along ordinary gynecologic lines. In cases in which

these operations are to be performed for the relief of one-child sterility certain special principles, however, assume importance and should be mentioned.

The operation should always be preceded by a complete sterility examination. The alterations in the mechanism of fertility which characterize the individual case should be carefully observed, and their importance estimated, in order to permit special attention in the details of the operative work to the items which have caused these failures. If marked congestion is present, as is usually the case, it should be relieved by careful preliminary treatment before the operation is undertaken. In cases of subinvolution the customary depletion should usually be accompanied by elevation of the uterus on a pessary for some weeks as a preliminary to operation, since even though there is no marked displacement, some descensus is always present, and this necessarily adds to the congestion. If any undue size or tension is present in the ovaries, it should be watched throughout the preliminary treatment, and if it is not relieved thereby, a reparative operation on the ovaries should be added to the necessary plastics. If the cervical secretions are abnormal and, more especially, if nabothians are present, careful preliminary minor treatment of these conditions will add very greatly to the probability of physiologic success and subsequent pregnancy. In the repair of cervical lacerations the shape and patency of the resulting os is, of course, of especial importance in these cases, the most important of all

desiderata being that the immediate result of the operation should be such as to leave the best of uterine drainage, and that denudations or exsections of the cervical tissue should be so complete as to remove all probability of future nabothians within the restored cervical canal. The routine performance of these operations without special thought of the existing failures in the mechanism of sterility is too often disappointing in its ultimate results.

Lowered fertility of physiologic origin (Chapter XIII) is of as much importance in the female as in the male, and the degree of fertility of both partners to the union should always be carefully estimated from this point of view.

As a result of the greater average age in the one-child sterilities a quite large proportion of the women concerned are in the later years of the child-bearing period at the time when they seek advice, and the degree to which the prognosis is altered by this fact may properly be spoken of here.

In general, the fertility of women is at its height in the first few years of maturity and decreases gradually with advancing age. It is a matter of common observation that the intervals between conceptions become longer as the woman's age increases. Fertile women in the twenties, and more especially in the early twenties, bear children under natural circumstances at intervals of not much more than eighteen months. The same women after thirty rarely conceive more often than once

in two years, and in the later thirties intervals of three years or more are more frequent.

It is generally believed that in cases of sterility in women over, perhaps, thirty-five the prognosis for relief by treatment is somewhat impaired by this natural decrease of prompt fertility, and it may be somewhat decreased in such cases when the conditions which determine infertility have been in existence many years and are consequently less amenable to treatment. This decrease in the prospect of successful treatment is, however, in most cases not very great so long as the woman is in the thirties. In one-child sterilities successes often occur in women who are thirty-eight or thirty-nine, or even over forty, when they first seek advice, though at this age every additional year renders the prospect less favorable.

The prognosis which can be given in these cases to women who are approaching or above forty varies greatly, moreover, in accordance with the conditions which have produced the individual sterility. In those cases in which the individual failure can be remedied promptly and without operation the prognosis is often good, but when they require prolonged treatment it is decreased by the fact that they will be just so much nearer the menopause at the time when that treatment is finished. Again, in cases which require merely plastic operations pregnancy often occurs within a few months after their performance, but in those in which the condition of the ovaries also requires operative treatment,

pregnancy rarely occurs in the first few months after operation, and most frequently not until after the lapse of a year, more or less. Here the added age must be taken into consideration.

After the first symptoms of the approaching menopause are apparent the chances of impregnation are very slight. The occasional cases of which every one has heard in which women who have been long without children conceive late in life and perhaps mistake their amenorrhea for that of the menopause, are probably always instances in which the previous infertility has been the result of local congestion in one form or another, and in which this is spontaneously ended by the decrease in blood-supply, which is one of the first consequences of beginning senile involution. When cases due to congestion present themselves even very late in life treatment of the congestion by minor means is, therefore, both justifiable and advisable if only for amelioration of health, but the prognosis given in respect to any possibility of pregnancy should be extremely guarded.

The menopause initiates the sterility of old age and any full discussion of it would be beyond our subject, but we so frequently see cases in which a little more detailed familiarity with its phenomena on the part of the physician would have saved his patient the fatigue and annoyance of a journey to seek a consultant's opinion, that a few words on the subject may not be out of place.

The menopause, like puberty, is always a time of

nervous and sometimes psychical instability. Under normal circumstances and with normal organs these effects should be slight, but in the presence of even very moderate abnormalities of the organs, these disturbances are apt to be exaggerated. Women often associate the change of life merely with the cessation of the menstrual periods, and the profession too often fall into the same error. It is, of course, a fact that the process of senile involution in which the uterus, the tubes, the ovaries (and in many cases the remainder of the genital tract) decrease from full-sized and active organs into mere vestiges, is the essential process; it is also a fact that senile involution in its entirety occupies a period of from five to ten or even more years.

In temperate climates it begins on the average in the middle forties, but may in individual cases begin either early or late in this decade.

The disappearance of the catamenia does not occur until decrease in the size of the uterus is well advanced, and consequently, as a rule, happens after the process of involution has been going on for from three to five years. It may then appear by one of several methods; most favorably there is a gradual decrease in the amount of flow until it finally fails to appear at all; more frequently, but a little less favorably, the intercatamenial intervals increase in length and the flow is irregular in amount, though with normal organs it should never be more than during active life; least favorably, and fortunately somewhat infrequently, a previously normal or but

slightly decreased flow fails to appear at a given period and does not recur, but such an abrupt cessation of function is usually followed by much discomfort from the hot flushes and other nervous phenomena of the menopause. The cessation of the periods, however, merely marks the middle period of senile involution, which continues progressively for a varying number of years.

Its earlier and later stages are marked by little symptomatology, but for a year or two on either side of the disappearance of the catamenia some nervous instability and lessened resistance to fatigue, *i. e.*, slight general deteriorations of health, are usually apparent under even the most favorable conditions. The degree of these disturbances is, however, so closely related to the degree of normality in the condition of the organs at the beginning of involution that women who are approaching the menopause are usually wise in seeking advice as to their local state even in the absence of any other reason.

Many of the conditions which are characteristic of one-child sterility—*i. e.*, subinvolution, the lacerations, the presence of numerous nabothians, the displacements, and the congestion which habitually accompanies all these conditions—are precisely those which involve a disturbed menopause.

The treatment of all these causes of sterility has been given in preceding chapters, and will, therefore, not be repeated here.

CHAPTER XVII

THE MARITAL HABIT

THE relation of physiologically correct conduct of the marital habit to health and fertility is a subject on which the medical student seldom or never receives instruction in the course of his medical education, and upon which practitioners of full training and otherwise wide experience often find themselves hardly fitted to advise their patients. Indeed, our experience among physicians who have come to us with their wives because their own marriages have proved infertile has shown us that even they frequently fail to appreciate in the management of their own affairs that physiologic laws are not affected by the marriage ceremony, and that the fact that the marital relation is ethically correct does not free it from the possibility of physiologic mistakes.

Among the laity many married couples certainly seem unable to apprehend this fact, and are led by ignorance into physiologic errors which may seriously interfere with their health and happiness. Habitual excess, for instance, between a married couple will be followed by exactly the same physical results which would ensue if they were unmarried, and the same statement is true of any other physiologic mistake.

The physiologic principles which govern the sexual relation are in accord with all that we know of general

physiology, but since they have so evidently failed to attract the attention of many practitioners, it may be well to review them briefly here.

Sexual excitement produces physiologically a temporary congestion of the organs in both sexes; if coitus follows, the congestion increases up to the appearance of the orgasm, after which it normally disappears or rapidly decreases. In the male it is gone in a few minutes after the ejaculation, and in the female all congestion should be completely gone by the time that the post-coital flow of serous secretion ceases (Chapter III, p. 41, footnote). With the disappearance of congestion the sexual appetite normally passes into complete abeyance for a period which varies with the individual.

This is the normal condition in settled married life and is the condition which should be aimed at in the management of the marital habit.

When for any reason the normal recurrent congestions of the organs fail to disappear and become persistent, the almost inevitable results are a chronic congestion of the prostate in the male and of the cervix, uterus, and ovaries in the female, usually attended in both cases by distention of the tubular glands in the prostate and in the mucous membrane of the cervix, which is, as a rule, accompanied by the appearance of a sexual overexcitability. This, in turn, tends to increase the congestion, a vicious circle is established, and much disturbance of function is an inevitable result. Such a condition often leads to some decrease of health and vitality

and too frequently to marital unhappiness. Chronic congestion may, moreover, in itself constitute or inaugurate the mechanism of sterility (Chapter IV).

The mistakes in habit which produce chronic congestion may be classified under overfrequency, undue restraint, and excitation without relief.

Overfrequency is perhaps the most common of these mistakes. If even normal coitus occurs too frequently the physiologic congestion which attends it often fails to disappear completely, and with sufficient persistence in overfrequency it tends to become chronic. Some degree of overfrequency is almost inevitable in the early days of married life, as will be appreciated after the succeeding paragraphs have been read, but this condition soon disappears.

A proper habit is to be obtained only by persistent moderate restraint of desire, the degree of frequency which is permissible and desirable varies with individuals, and must often be arranged by a fair compromise between the two concerned. The best indication is that when a proper degree of frequency has been established coitus is followed by a sense of comfort and well being, by immediate readiness for sound sleep, and by absence of desire during the succeeding days.

Five or six times in the three weeks or thereabouts of the menstrual interval is probably an average frequency among normal couples in young adult life and after they have settled into marital life. A few may require slightly more, many are better off with less.

Undue restraint is in itself a less common cause of trouble. Celibacy throughout life is probably in the long run, and from a merely *physiologic* standpoint, to some slight degree an unfortunate condition of life; but the maintenance of complete chastity throughout youth and into adult life, though from a merely mammalian standpoint somewhat unnatural, is physiologically essentially harmless so long as the individual (of either sex) pursues a single life. Complete restraint in a couple who are living together in the daily contacts of marital life is, however, so unnatural that it is almost inevitably followed by disturbance in their sexual organs. In point of fact, it can hardly exist between normal individuals without verging upon the third and most extreme mistake of habit.

No condition is so harmful to the organs as the continued presence of desire without gratification. Any frequent excitation of this condition inevitably leads to chronic and usually severe congestion. It may seem unnecessary to give this warning, but experience shows that this is one of the common mistakes into which, in one form or another, young people are not infrequently led by confusion between the ethical and the physiologic. A married couple should then always carefully abstain from physical excitation except when it is to be followed by intercourse.

A frank and non-prurient attitude about the fundamental facts of sex physiology has become in recent years much more common in Anglo-Saxon communities, but

far too many young people are still allowed to marry without a proper degree of knowledge of this subject.

Whenever it becomes necessary for the physician to enter upon it with a patient of either sex he will find that the adoption of utter frankness and of a wholly scientific and impersonal attitude will render its discussion surprisingly easy to both sides. If the first questions show that the relation is normal and satisfactory, nothing further need be said, but on any suspicion of a mistaken habit, the inquiry should persist, and if its existence is discovered, the questions can hardly be too detailed. Patients of either sex who have adopted any degree of unphysiologic habit through ignorance usually pursue the subject with keen interest, and are always most grateful for the advice which follows.

In cases of sterility it is always well to question each of the couple separately, since it is not uncommon for either one to have experienced trouble which has not been fully appreciated by the other.

A long-continued and happy marriage is undoubtedly the most desirable life condition for any individual, and in such a marriage sexual satisfaction soon comes to seem a mere incident and of far less importance than the other conditions of the relation, but no physician of wide experience can fail to appreciate that the most complete marital happiness seldom exists without reasonably satisfactory sexual relations, nor that sexual dissatisfaction is one of the most frequent causes of the failure of marital happiness. The existence of the

sexual relation is the fundamental difference between marriage and any other human relation, and the attainment of a reasonable degree of mutual satisfaction in this matter is an object which each partner to a marriage should properly and frankly endeavor to obtain.

In recent years some few overcivilized women have been taught an unwillingness to treat the marital relation frankly and rationally, and whenever a psychical condition of this sort has been followed by a chronic congestion of the organs, the physician may greatly help his patient by a fair and frank statement of the true physiologic and ethical bearing of the normal sexual sensations, upon both health and happiness in the married state.

The ethical aspects of the artificial prevention of pregnancy constitute a subject upon which very diverse opinions exist and are discussed. This side of the question is one which it seems to us should be left for the conscientious consideration of the individuals concerned, or to a spiritual adviser. Its physical relations to health and fertility are within our province and must be mentioned in this chapter.

The promulgation of information about the prevention of pregnancy is in most states of the union illegal except in instances in which the occurrence of pregnancy would be dangerous to life or health. It may be said here that several of the methods which are commonly in use for this purpose too frequently lead to the provocation of congestion, and there are many instances in which prevention of pregnancy, undertaken for economic or

other reasons and intended to be merely temporary, sets up a sterility, which unless promptly treated may become permanent. It should be generally understood that the regulation of pregnancy is seldom entirely harmless, and that even when vital conditions render it absolutely necessary it should not be undertaken without careful consideration and under medical advice.

When a chronic congestion and its consequences have been inaugurated by any of these mistakes the obvious remedy is correction of the mistaken habit, but the effort which is often necessary to this end is greatly lessened, and the recovery of the organs is hastened, by direct treatment of the congestion. A little massage of the prostate in the male, and vaginal depletion by some one of the glycerin preparations (best in the form of suppositories) in the female, will in combination with corrected habit promptly relieve congestion. All such patients should, however, be given a full sterility examination, both because it is important to ascertain that no other predisposing cause of the congestion is present, and especially in order to exclude the existence of any beginning infection. Chronically congested organs are, as has been said earlier (Chapter IV, p. 65), particularly susceptible to infection, and if any degree of infection is already present no correction of habit or mere depletion will prove satisfactory.

One other, but closely allied, subject may properly be included in this chapter. It is certainly noticeable that the rising generation is disposed to treat all ques-

tions of sexual physiology in a much more frank and reasonable way than was the habit of their parents in youth. As a part of this mental movement in the community there is an increasing habit of calling upon the physician for advice in anticipation of marriage, and most patients who seek premarital advice desire and should receive a fairly complete statement of the physiologic and ethical aspects of the marital relation. It should be easy for the physician to adapt the principles which have been already discussed to the circumstances of a premarital interview, and in general they need no repetition here. In view, however, both of the great frequency of sterile matings and of the fact that many infertilities are due to causes which do not readily attract attention, a few words on the prevention of sterility may be included in any premarital interview in which the appearance of the patient suggests the possibility of an infertile marriage.

The infertility of a given marriage is, in fact, so often the result of constitutional conditions that in the course of a premarital interview the physician should at least always pay careful attention to the general state of his patient, and in the presence of any evident lack of full vigor should urge the importance of "conditioning" in promoting fertility. Any evidence of malnutrition, anemia, or the existence of a focus of auto-intoxication is of especial importance (Chapter XIII). Although most couples when they marry desire at least one child, many of them would prefer that the first pregnancy should

not occur immediately, and the subject of the prevention of pregnancy is for that reason often introduced into a premarital interview by the patient. There is a consensus of all authorities to the effect that the prevention of pregnancy for any reason tends to decrease fertility, and that even a temporary adoption of methods to this end, for economic or other reasons, if at all long continued too often results in the production of an actual sterility. Some statement of this fact is, therefore, peculiarly appropriate to, at least, such premarital interviews.

The question of whether a woman who is intending marriage should have a local examination as a preliminary is one which is today not infrequently submitted to the physician, and upon which differing opinions may well be held. If the patient has had any symptoms which raise the question of possible pelvic disturbances such an examination is well worth while and should be advised. In the absence of even slight pelvic symptomatology we believe that this question should be decided by the preference of the patient; that is, that an examination should not be urged upon a patient who is reluctant to submit to it, nor denied to one who would prefer to make sure of her entire normality before entering upon marriage, but that the very undesirable consequences which attend upon the natural process of dilatation of an abnormally rigid hymen should usually be mentioned to the patient whenever this question is under consideration.

If at such an examination the hymen is found to be unusually inelastic, it is certainly for the patient's interests that it should be dilated under anesthesia as a preliminary to marriage. If the hymen is lax or normal such a dilatation need not be urged, but we believe that it should not be refused to a patient who requests it.

SUMMARY

This chapter has dealt with three somewhat separate subjects or, more properly, with three divisions of one subject, which may well be summarized in conclusion. First: All the aberrations and mistakes of habits result in the establishment of a chronic congestion which, as was said in Chapter IV, produces sterility by the production of hostile secretions, and which may if long continued lead to alterations in the mucous membranes, in the organs of either sex, which may then become self-perpetuating. Second: Treatment, in cases in which these conditions are simply the result of incorrect habit, consists of the correction of the habit, and also, if necessary, of the direct treatment of the congestion and its consequences. The necessity for correction of habit imposes on the physician the duty of ascertaining the existence of deviations in habit by tactful but clear cross examinations of both patients; and of convincing them of the importance of the subject by a frank exposition, both of the physiology of the subject, and of the failures in that physiology which are the inevitable consequences of such mistakes. This duty of plain talk is one which

he has certainly no right to shirk if he undertakes the care of any sterilities. It is, moreover, one which becomes easy if approached fearlessly and in the proper spirit. Third: It treats of the opportunity for *prevention* of these mistakes which is afforded to him in the course of premarital advice. Modern medicine emphasizes the importance of prevention at every point. We personally believe that the physician will increase his usefulness to his patients if he lends his influence to the promotion of the increasing custom of seeking such advice as a preliminary to marriage.

CHAPTER XVIII

PREVENTION OF STERILITY BY THE CARE OF PUBERTY AND OF MENSTRUATION

IN writing of underdevelopment as a cause of many female sterilities (Chapter V), we have already referred briefly to the very rapid and extreme changes which the growing girl undergoes during puberty and of their meaning. Many sterilities are, however, the result of lack of care during puberty, and the subject is one which is little taught to the physician during his education. It is also one on which information is universally desired by those who have themselves been so afflicted. For all these reasons some special discussion of the management of puberty in both sexes seems to us not out of place in a book of this character, even at the risk of repetition. It will be prefaced by a brief recapitulation of the physiology of puberty.

Throughout the mammalia, and certainly in the human race, the part which the male plays in reproduction occupies less of his time and certainly causes greatly less disturbance of his life habits than is involved in the processes of menstruation, pregnancy, parturition, nursing, and the care of infants, which form the share of the woman. In accordance with this difference of function the changes which occur in the boy at puberty are far less profound than those which the girl must undergo. Failures of development during puberty are correspond-

ingly much less common in the male than in the female, and the management of the individual at this time is also much less generally a matter of prime importance.

In the boy the voice deepens during puberty as a result of the enlargement of the larynx, the growth of hair over the body increases, the sexual apparatus as a whole enlarges, and the testicles undergo full development. There are few, if any, changes in the general physiology, and the vital force required for these local changes is comparatively small. An ample and stimulating diet, similar to that to be described later for the girl, and exercise enough to insure its prompt and satisfactory assimilation, are highly important; but the normal boy is always hungry and prone to abundant exercise, and at that age he is seldom apt to overwork mentally to any serious degree. It is only in delicate or weakly specimens that especial care is demanded. When it is necessary it is exactly similar to that which is indicated for the girl and, to save repetition, will be omitted here.

In the female sex the physiology of puberty is more complicated. Its most noticeable phenomenon is the appearance of menstruation. The menstrual flow or catamenia is peculiar to women. Maintenance of its normality is a matter of dominant importance to their health, general and local, and comprehension of its meaning is essential to any complete understanding of the physiology of puberty. It is best explained by describing its evolution from the processes which exist in the other mammals.

In most animals there is a breeding season which is limited to one portion of the year, and is succeeded, except in the case of pregnant females, by a period of entire inactivity of the sexual organs which covers the remainder of the year. This is especially true of those animals whose life habits keep them in constant danger from their enemies or who suffer from scanty food and exposure to the elements during the inclement season. It is, however, a curious and significant fact that when animals which in the wild state have but a single brief breeding season are submitted to domestication, their breeding season usually recurs twice or even many times each year. Domestication involves protection from enemies, housing in winter, and abundant food the year round. The general drain upon their energies becomes far less than it was in the wild state and it is probable that the superabundance of energy produced by this fact, and by higher feeding throughout the year, results in these more frequent activities of the sexual organs, and consequently of reproduction.

Investigations among the most primitive races of existing mankind have shown that in them there are distinct traces of a limited breeding season in the spring, the great majority of births among them occurring at a corresponding date, and it is believed by many anthropologists that in primeval man and his ancestors reproduction was probably limited to such a season. In civilization the human race is, however, in a physiologic sense the most domesticated of all animals, and in it

reproduction occurs at a practically uniform rate throughout the year.

The menstrual month in the human race corresponds to what is known as the estrous cycle in the other mammalia. In women menstruation occurs upon an average every four weeks, and the four divisions of the estrous cycle are much less well marked than in the other animals, in which they are quite distinct.

The first stage of the estrous cycle, which in the animals ushers in the breeding season, is a stage in which the genital organs are deeply congested and the increased amount of blood which they thus receive throws them into activity. In all the animals the genital tract of the female is then moistened by an increased secretion, but except in our near relations, the apes and monkeys, and in a few highly domesticated animals, notably cows, horses, and dogs, the flow is entirely colorless. In women a few days to a week preceding menstruation and the days during which the flow is most active correspond to this stage of congestion and increased secretion, but in women alone of all female animals the flow during the latter part of this stage is highly sanguineous, consisting of a mixture of mucus and blood. During this stage many women are habitually nervous and even irritable or mentally depressed, and there are few women who have not experienced these symptoms occasionally. Almost all women and many animals show lassitude and are unfitted for severe exertion during this period.

The next stage of the cycle is the stage of decreasing

congestion and normally of a sense of returning well-being and comfort. In women this is represented by the last few days of decreasing flow and the first one or two days after its cessation. In point of fact, the brownish staining which is most characteristic of this period does not necessarily and always imply continued flowing. It represents merely the cleansing of the canal from blood which has already escaped from the vessels. This is then washed out by the ordinary secretions, which are, of course, still somewhat profuse.

In women the third stage, that of return of the organs to inactivity, and of regeneration of the mucous membranes from the microscopic breaking down which has occasioned the flow, is of brief duration and uneventful.

In the fourth stage the organs are inactive and quiescent. In many animals this stage of sexual inactivity lasts during nine, ten, or even eleven months of the year. In women and in a few other animals—*e. g.*, rabbits and many other rodents—this stage of rest is brief, in women not more than two to two and a half weeks. In women only the inactivity of the organs is so far from complete that reproduction—*i. e.*, impregnation—may occur at any time.

In women more, perhaps, than in any other female animals the general physiology—*i. e.*, digestion, circulation, and all metabolism—is in an unstable state and easily upset by small forces during the first and second stages of the estrous cycle. This is especially true of all women during the first few days of the active flow and

of many women during the days which precede it.¹ The general nervousness and depression and, indeed, the sense of weight and bearing down which many women feel during these days is the result of the congestion of the organs and is probably in some degree experienced by the females of other animals. The cramping pains which so often accompany the active stage of menstruation are probably peculiar to women and are usually the result of poor uterine drainage and of consequent difficulty in expelling small clots from the uterine cavity.

During puberty and when the partially developed organs of the growing child are not as yet fully adapted to the performance of their functions menstruation is often irregular and imperfect, and the degree of care which is given to the first few periods often determines the satisfactory or unsatisfactory character of the catamenia during succeeding years. The mother of a girl who is approaching puberty should always warn her daughter of what is to be expected, should tell her that there is nothing abnormal in the appearance of catamenial blood, and should urge her to report the fact at once. She should be instructed that she can take no more important supervision of her daughter than to insist on complete rest during the first few menstrual periods. The child should remain in bed or between the bed and sofa, as may be most restful to her during the whole of the first period, but should be warned that

¹ An excellent book upon this subject is Marshall's *Physiology of Reproduction*, 2d ed., Longmans, Green & Co., London, 1922.

such extreme care will not be necessary during the rest of her life. If the first catamenial period passes over easily, she may be up and about the house during the last day or two of the next period, and the amount of care taken should decrease gradually during succeeding months in accordance with the amount of nervous or other general disturbance, or of local discomfort which the individual girl experiences.

No menstruating woman is fit for *extreme* physical or mental exertion during the two or three days when the flow is most active, or at the time when she experiences her greatest discomfort, whether that is before or during the flow. Most women are the better in the long run for lessening the ordinary activities during those days, but the exact amount of exertion, mental or physical, which women as a sex can undertake to the best advantage during the catamenia varies so greatly with their individual constitutions and temperaments that it cannot be stated in general terms.

The habit which an individual woman eventually adopts should be regulated by observation and experimental trial of the amount of rest during menstruation which yields the best results on her general vigor both during the succeeding weeks of that menstrual month and during the next period. It is a fact which is not always appreciated that indiscretions committed during one flow are apt to show in the amount of pain or nervous discomfort experienced during the succeeding menstruation.

Mothers are too apt to think that puberty is com-

prised in the first few actual catamenia, and the physician should warn them that, in point of fact, the processes of puberty cover several years. In temperate climates the first menstruation usually appears at about thirteen or fourteen years of age, but the processes of local and general development toward full femininity have been under way for approximately two years before this time, and complete development is often not attained until something like two years afterward.

During these three or four years the whole frame and physiology of the growing girl undergo, as has been already said, extensive changes. Until then male and female children are physically closely alike, they play together and have the same habits of life, but with the appearance of puberty the whole figure of the little girl alters, the pelvis enlarges, and its shape changes in preparation for the ultimate necessity of permitting the passage of her children. With the broadening of the pelvis the hip-joints are carried further apart and the shape of the knee-joints alters in correspondence, the back hollows, the abdomen lengthens, and its proportionate relation to the chest is greater than in childhood or in the man.

The female child usually runs as fast as the boy, but the adult woman can rarely run with her brother or engage in any athletics on wholly equal terms with him. In women of feminine type the locomotive abilities have usually been in part sacrificed to their necessities in the processes of procreation.

Similarly, her whole physiology—digestion, assimilation, circulation, etc.—alters and becomes adaptable to the variations in its action which are demanded of her in the varying phases of the estrous cycle, and especially during the processes of pregnancy when that occurs. Without entering too far into particulars or more than referring to the further changes in secondary sexual characteristics, such as the appearance of the breasts, the changes in superficial fat, etc., it may be said briefly that during these two years the whole girl changes in almost every respect, and the demands made upon her vitality in effecting these changes are far greater than is generally realized.

Each woman starts in life with an amount of vitality, of physical force, which is individual and characteristic of her individually. Those who are best equipped in this respect may be able to expend vital force freely in many directions during the years of puberty, and still have enough left to complete these many developmental changes, including the growth of the generative organs from an infantile to a completely mature condition. Such individuals need no special care, but there are not a few girls in whom the inherent vital force is insufficient to meet all the many and varied demands which are imposed upon the child by our complicated and highly artificial life, and at the same time complete the developmental changes satisfactorily. If the strains of an artificial and unhealthful social life and the very severe strains of forced education are insisted on and

made the first object, development too frequently fails because the force which should have been expended in effecting the changes necessary to full maturity has been expended for other purposes.

In order to attain the full physical development on which future health and happiness so largely depend, care in two directions is necessary for the developing girl. In the first place an abundance of vitality should be cultivated by care that she obtains the necessary diet, exercise, and periods of sleep and rest. In the second place, at any sign of flagging the demands made upon her by the activities of civilization should be temporarily lessened, and held at a lower level in the interests of her development and until full health and vigor return.

The diet necessary to growing animals varies somewhat both in quantity and in kind from that which keeps the adult in the best condition. Youthful individuals of either sex need throughout the period of growth, and more especially during puberty, somewhat more food in proportion to their weight than is necessary for adults, and they need also a larger proportion of the more stimulative elements in diet, which are especially related to growth and development. These are the proteins, the very essential vitamins and certain of the mineral salts, more especially calcium, phosphorus and iron, but since the dietaries which contain the essential elements have been already discussed at length in Chapter XIII their repetition is unnecessary.

The human digestion even in youth does not assimilate these necessary elements in diet to the best advantage unless the individual is in the habit of taking fairly active exercise, and just as it is plainly of no use to place such food upon the table unless the child eats it, so it is also of comparatively small use to make her eat it unless we provide for its adequate assimilation into the body by regulation of the other habits of life (Chapter XIII).

At or about the age of puberty, and especially with the beginning of menstruation, a considerable proportion of girls become to some degree anemic, and in some cases these anemias become severe. Even a slight degree of anemia exerts a very unfortunate effect upon development, and in the care of girls during puberty even slight degrees of anemia should be treated energetically and from the start.

The psychic changes which occur in the female child at or about puberty are many and marked. Almost everybody has noticed the lassitude, shyness, and tendency to introspection which characterize many girls at about this time. In girls of psychasthenic tendency these changes may be very marked, and their appearance even in slight degree in any girl is always evidence that the demands of development are encroaching upon the vital force necessary for the other processes of life. Especially in psychasthenic cases this condition should be combated, and combated promptly, by the stimulative diet already described in combination with the

moderate amount of out-door air and exercise (during the intermenstrual interval) which is always necessary to make the assimilation of such a diet possible.¹

If such girls are permitted to neglect exercise and appetite, and are pressed mentally in school or college, they are sooner or later apt to be affected by the decreased and sometimes painful menstruation which is characteristic of retarded development of the organs. If such neglect of their bodily necessities continues, their development may be permanently checked.

One precaution will be found advisable for all developing girls and of great importance to all but the most vigorous. Mental work should be intermitted altogether or at least made light during the most active days of the flow, or the period at which the girl is least comfortable. At first sight this seems incompatible with scholastic success, but in point of fact the mental work done during these few days is seldom good, and must often be repeated, while the lassitude induced by the effort to work as hard at this time as at others often lasts for a long time afterward. As a matter of practical experience most girls accomplish more and better work in the course of the month if they do little or nothing at this time. In most scholastic institutions girls who fail in an examination taken during their periods are permitted re-examination. It would be far better for their physical

¹ For the comparatively few boys in whom psychasthenic tendencies become apparent during puberty the same treatment is essential, but, as has been said, the young male of the human race ordinarily tends naturally even during puberty to active play, abundant physical exercise, and a corresponding appetite.

interests if they were altogether excused from examinations, or other severe mental strains, at this time.

The amount of bodily exercise which may be taken with advantage during the period also varies greatly with different individuals. Some women do best with absolute rest for one or two days, some are most comfortable if they keep about with care, and many can pursue the routine physical duties of life without harm. Comparatively few women are fit for really active muscular exertion during these few days, and no woman, far less any developing girl, is safe in submitting herself to competitive athletics or other extreme muscular exertion at this time. We have seen not a few instances in which one of the very exceptional women who are able to keep up moderate athletics with comfort during menstruation has been upset for life by an excessive physical stunt at the time when she was actively unwell, and has never again had a comfortable period.

Many cases of underdevelopment can be improved and even brought to full development by subsequent care, especially if this is obtained during early adult life, but both experimental work among animals in the laboratory and clinical experience in the human race show that reasonable care during the developmental period is far more effective than anything that can be done later to repair failure.

SECTION V

THE CLINICAL CONDUCT OF A CASE

CHAPTER XIX

THE EXAMINATION OF THE CASE

THE truism that "successful treatment is dependent upon the previous attainment of an accurate diagnosis" is perhaps more true in the management of sterility than in the general practice of medicine, and too much emphasis can hardly be laid upon the necessity of preceding any treatment by a complete and detailed process of diagnosis, such as is here to be described in the form which we individually have found most satisfactory.

The full and accurate examination of both partners which we believe to be essential to ultimate success cannot be made in a few minutes nor at a single visit. It should include a careful history of both patients, a careful general and local physical examination of the male, a thorough general physical examination of the female, and a physical examination of her genital organs by the usual gynecologic methods, which must, however, be modified in technic in a way to be described later. This must, also, always include a microscopic examination of the several secretions of her genital tract. In not a few cases it is necessary to follow it, too, by an insufflation of her fallopian tubes, which can, however, usually be done at the same sitting. These examinations of the two individuals can rarely be completed under two hours and may occasionally occupy a longer time.

This survey of the two individuals in their habitual condition should be followed by a postcoital study of their mating which, moreover, furnishes in most cases a sufficient microscopic survey of the male. This is best made at a subsequent visit on another day, first, because the preceding examinations will have been quite long enough for both the patients and the physician, and, second, because it is desirable that the postcoital examination should be made when the secretions of the woman are free from the disturbances which are necessarily involved in the preceding study. Finally, a satisfactory determination of the slight and easily missed alterations in the uterus and its appendages which are often essential to diagnosis in sterility usually demands an examination of the woman under anesthesia; indeed, this examination so frequently reveals facts of importance even when the previous examination has seemed to be entirely satisfactory that it is a good rule never to give an opinion on sterility until anesthesia has been used. By the employment of primary gas-oxygen anesthesia it is usually easily possible to make this examination at the conclusion of the postcoital with extremely little disturbance to the patient or to the office.

After all the evidence has been obtained the physician should be in a position to give a really reliable opinion upon both the diagnosis and treatment of the case.

So detailed and prolonged an examination may seem unnecessary to those who have not had considerable practical experience in the management of sterility,

but we grow daily more convinced that any opinion given without all this study is too frequently entirely incorrect. No part of this full examination should be hurried or neglected; it is never possible to predict which part of it, from the history to the final examination, will prove the most important in the diagnosis of a given case.

These several methods of examination must now be discussed in detail.

The histories should follow every detail of the past health of both patients and not be confined to the sterility alone, since it is in many cases dependent either on the general condition, or upon slight alterations in the functions of the genitals on which great light is often thrown by past symptomatology. Either of these conditions may not infrequently be of long standing and believed by the patient to be unimportant. Such factors as diet, overweight, undernutrition, nervous debility, drug habits of any kind, marital habit, menstrual peculiarities, and the auto-intoxications should receive especial attention both in the history taking and in the general physical examination of both patients. This examination should always be thorough, but since it is made by ordinary methods demands no special description. Any suspicion of an especial abnormality in general condition, such as, for instance, anemia, syphilis, or one of the auto-intoxications, should, however, be carefully investigated by the specialized methods which are now available.

The localized physical examination of the man

should include an inspection of the penis, careful palpation of the testicles and epididymes, and a rectal examination of the prostate and vesicles. Intra-urethral examination is not necessary as a routine procedure, and may be reserved for those cases in which the microscopic examination of the semen, as made at the postcoital examination or otherwise, suggests its necessity.

In the pelvic examination of the woman the use of the speculum is perhaps more important than in other cases. The color of the vagina and cervix should be noted on account of the importance of the chronic congestions. The shape and position of the os and cervix are of notable importance, and the chemical reaction of both secretions should be taken. The gross appearance of both the vaginal and cervical secretions should be noted and specimens of each should be prepared for microscopic examination. In this connection one precaution is worthy of emphasis. Since there are not a few cases in which a normal serous secretion is all that will be seen to escape from the cervix even in the presence of an abnormal secretion within its cavity, these specimens should be withdrawn from within the os by forceps, or the very light use of a blunt curet, in all cases. Without this precaution the examination can never be regarded as complete. The microscopic character of the vaginal content is of importance chiefly when its fluids are overacid, in which case the character of the preponderating micro-organism is sometimes worth knowing. In the cervical secretion the amount of mucus, the

degree and character of any leukocytosis, and the possible presence of spermatozoa are the chief points for observation.

The speculum examination should be followed by a careful palpation of the organs. This should, of course, note the size, consistency, position, and degree of mobility of both the cervix and uterine body, as in any gynecologic examination, but in sterilities the lateral deviations of either the uterus or cervix are also of much importance and should be carefully noted. The condition of the broad ligaments and uterosacrals with special reference to their flexibility and degree of tension is also all important and should receive careful attention. The condition of the uterosacrals can hardly be ascertained without a rectal examination, and this is best made by inserting the second finger into the rectum while the forefinger is in the vagina and the other hand upon the abdomen. This combined examination is also of great value in the examination of the tubes and ovaries, and may in our opinion be insisted upon as essential to the detection of the slight abnormalities which are so often all important in the examination of sterilities. The situation of both ovaries should be carefully palpated. Normal ovaries in the latter half of the menstrual interval are seldom perceptible to the examining fingers, but with care and skill, and in thin women with relaxed abdominal walls, the enlargement due to the corpus of menstruation may be perceptible by this method for a week or more after the period even without anes-

thesia. Non-ovulating ovaries distended by retained follicles or persistent corpora are so far firm and rigid as to be often easily perceptible under these conditions, even in the absence of gross enlargements, but a positive determination of their presence is seldom satisfactory, and a negative is rarely possible without anesthesia. The comparison of examinations made before and after a period, and if possible before and after several succeeding periods, is always valuable.

If anything in the past history or in the physical examination of the female genitals raises any question as to the condition of the tubes, an insufflation of them should now be considered. Our experience, however, leads us to believe that this test should not be performed as a routine matter, but should be regarded as a distinct surgical procedure. For that reason its indications, contraindications, and technic will be discussed in the chapter on the Surgery of Sterility, and omitted here.

The postcoital examination on the next day should include both gross and microscopic examination of specimens taken from the vagina, cervix, and, if necessary and possible, from the uterine cavity, as soon as is convenient after coitus. The patient may come to the office for this examination, since it is only very exceptionally, if ever, that the vagina does not contain sufficient spermatozoa for this test even after she has dressed and moved about the room, but results are apt to be better if she drives rather than walks to the office. The examination should be made within the first two

hours, and preferably in the first hour, after coitus. Even if the vaginal secretion is normal a large proportion of the spermatozoa will be found dead or feebly motile even half an hour after coitus, but careful search of the specimen will usually show areas in which the vaginal epithelium is sparse or absent. These areas are largely seminal, *i. e.*, but little mixed with the vaginal secretion. If the spermatozoa are everywhere abundant, and when found in these areas are preponderantly in good motion, and morphologically normal, fertility on the part of the husband may usually be assumed; but if the vaginal secretion is abnormal or if the examination has been delayed until more than two hours after coitus, even an entire absence of motility in the vaginal spermatozoa is no evidence against the fertility of the husband. In such cases a direct examination of the unmixed semen may become necessary. The number, motility, and vitality of the spermatozoa should be noted, and the presence or absence of abnormal elements, as described in Chapter VIII.

In a normal cervical cavity spermatozoa usually retain motility for several days. We have found them in active motion as late as the fifth day. Such prolonged motility of normally formed spermatozoa in large numbers in the cervix is always good evidence of normal fertility on the part of the husband, but except in such cases the evidence obtained from the postcoital examination is never so conclusive as to the degree of his fertility as an examination of his semen when unmixed with the secretions

of the woman. The cellular characteristics of the cervical secretion should be observed again, and compared with those found on the preceding day. The muscular contractions which occur during coitus frequently result in the expulsion from the cervical glands of a much increased amount of abnormal secretion.

The final examination under anesthesia needs no prolonged description, since it is to be a mere repetition of the previous palpation under altered conditions. In addition to its acknowledged superiority in all gynecologic work, it possesses one great additional advantage in cases of sterility. Comparison of the examinations with and without anesthesia permits one to determine whether the rigidities of the uterine ligaments, which are here so important, are due to inflammatory engorgement or to mere spastic contraction of the involuntary muscular fibers which they all contain. A rigidity of the uterosacral ligaments, or of the base of the broad ligaments which persists even under full anesthesia, is usually, and perhaps always, dependent upon lymphatic absorption from an inflamed cervical mucous membrane, while the spastic contractions of the same ligaments which do disappear under anesthesia are ordinarily symptomatic of functional congestion, such, for instance, as those which are the result of physiologically incorrect marital habit. Persistent contractions of one broad ligament as a whole, or of the upper portions of the broad ligament, usually indicate the presence of old infection in the uterine body or tubes, or of definite

peritoneal adhesions. In both cases the distinction is an important element in diagnosis.

All the findings should have been carefully noted at the end of each examination. On the conclusion of the whole process the record should be reviewed as a whole, the case of each partner should be considered separately, and its influence on their mating carefully weighed.

At this point a word of caution may be inserted. The evidence obtained by the postcoital examination is very dramatic and striking in appearance and may often seem at first sight to outweigh the other data; but as one's experience increases he is more and more impressed with the possible errors which are involved in this examination from failures of technic, and we are confident that the best results will be obtained if it is carefully relegated to its proper position as only one of the items of evidence collected, and as by no means conclusive unless it agrees with the other data obtained. An overestimation of the value of this examination is a very common mistake in practice. If the findings of each separate examination of either partner coincide throughout, the diagnosis may be considered as established; if, for instance, in the case of the man the testicles are lax, the number of the spermatozoa is less than normal, and their motility or vitality is distinctly low. If, in addition, the history and general physical examination show him to be overworked and undernourished, the diagnosis of decreased fertility from constitutional condition is clearly evident. A careful application

of the same familiar diagnostic principle to all the conditions which have been discovered in both patients and then to their mating as a whole will almost always result in a very definite diagnosis, and in clear indications for treatment. From these it should be possible to construct in most cases a quite reliable prognosis.

In cases of sterility an accurate prognosis seems to us especially important for the following reasons: In ordinary practice, in which the questions presented involve only the patient's present danger or future health, the physician may, of course, properly advise or even urge treatment. Such conditions are, of course, present in some sterility cases, and in such the consultant's function is evident. In cases in which health is not involved and the question which is dependent upon treatment, whether that proposed is operative or non-operative, is merely that of the relief of sterility, we believe that his only duty is to lay the facts and prognosis before the couple. The decision as to whether they do or do not care to undergo the amount of treatment recommended, for the degree of chance which is offered them, should then be theirs and theirs only.

CHAPTER XX

SURGERY OF STERILITY

THE indications for minor treatment of both male and female infertilities have been given in preceding chapters, but certain modifications of operative technic which are important in cases of sterility must receive special mention and will form the subject of this chapter.

In recent years the tendency in the treatment of sterility has been largely away from surgery, and particularly from indiscriminate and routine surgery. To this change two advances have chiefly contributed. The profession have come to realize very generally that the sterility of a marriage may be due to the infertility of either partner, and that probably in the long run female sterilities are no more frequent than sterilities of the male; most men now recognize that no woman should be operated on for sterility unless the fertility of her husband has been previously ascertained. Again, a growing recognition of the importance of preceding operations by an accurate, differential diagnosis of the actual cause or causes of the sterility is resulting in a great decrease of the empiric surgery which was formerly practised.

Much more attention is now being given to examination of the male, but though most men of the present time recognize the necessity for this procedure, the examination to this end is very frequently superficial.

It is evident that too many of the profession still believe that the mere presence of motile spermatozoa in a recent specimen of semen is sufficient evidence of full fertility on the part of the male. Out of 100 recent cases there were 60 in which the female had been already operated on, of course because her condition was supposed to be the cause of the sterility, but of these 60 there were 22 in which an examination of the semen with adequate technic and thoroughness (Chapter VIII) showed that the sterility of the marriage was, in fact, due to decreased fertility on the part of the male.

There are but few cases of male infertility in which operation is indicated. These few are all complete sterilities, and have already been discussed technically in the section on the male (Chapters VIII to XII). They need no further mention here.

The application of a careful differential diagnosis of cause to all cases will reveal many cases of female infertility in which the predisposing cause is constitutional, and will considerably decrease the number of cases in which any surgical treatment is indicated; but even with all the advantages which we now possess there are many sterilities of female origin in which an operation must be the first step in the treatment. The indications for and against these operations have already been given in the section on Sterilities of Female Origin (Chapters IV to VII), but full discussion of the technic was there omitted for the sake of clearness and must be undertaken here.

The operations are numerous and often complicated, but they are, in the main, procedures which are described in every gynecologic text-book, and which are familiar to every gynecologist. It is not our intention to expand this chapter into a text-book on operative technic in gynecology. The profession possesses many admirable works on this subject. We propose, then, to restrict the subject of this chapter to the discussion of certain alterations or additions to the technic which are essential to the relief of sterility. These special points in technic are usually unimportant when the same operation is employed merely for the relief of pain or other symptomatology; and those who are not especially interested in sterility too often fail to appreciate the importance of the special technic in cases in which a sterility is the indication for the operation. In the series of 100 recent cases alluded to above, 27 women had already been submitted to vaginal operations, and 33 to abdominal. In many of them the failure to relieve the sterilities had been due to the neglect of constitutional factors, but there were 18 out of 27 clearly operative cases in which it was necessary to operate again in order to make minor corrections which might equally well have been attended to at the original operation, and this factor seems to us enough to warrant this chapter.

The cases to be discussed fall into two classes: First, those of functional origin in which some abnormality of physiology has set up local changes which have become self-perpetuating and which demand an operation

in combination with constitutional treatment. Second, those in which the main object of the operation is the removal of some pathologic entity, but in which the secondary changes in the mechanism of fertility must also be attended to. In both these classes the technic of operation is, however, the same, and for this reason a discussion arranged in accordance with the anatomy of the female canal from the introitus to the ovaries will be more appropriate here.

The surgery of the vagina is seldom or never altered by the presence of sterility. Restoration of its mechanical functions by the operative treatment of mal-development, lacerations, and cicatrices is well handled in all the text-books. Alterations in its secretion are usually symptomatic of changes elsewhere in the tract, and in themselves never demand operative treatment.

In the cervix, however, the case is very different. Alterations in the secretions of the cervix are among the most frequent of the disturbances of mechanism which produce sterility, and the determining cause of these alterations is often found in the cervix itself. Examination of the cervical secretions may show the existence of pathologic changes in the cervical mucous membrane as a result of long-continued chronic congestion, and these have often become self-continuing; or this examination in combination with inspection and palpation may demonstrate the existence of defective drainage of the uterine and cervical secretions as a consequence either of too narrow an os or of the obstruc-

tion which has already been described in Chapter V as the result of air anteflexion of the cervix. In either case surgical interference is demanded.

Distention of the cervical glands by retained secretion as the result of chronic congestion and usually of mild infection demands a deep and thorough curetage of the cervical cavity, and this must usually be followed by repeated disinfections. It is curious how often curetage of the cervical mucous membrane is forgotten and omitted in the course of a curetage of the uterus, and this in spite of the fact that in cases of sterility, curetage of the cervix is often the more important procedure of the two. Even where the altered condition of the cervical glands is the result of congestion and infection alone, and was not originally a result of poor drainage, recovery is to a large extent dependent upon the existence of the best of uterine drainage, and in such cases correction of even the milder degrees of narrow os or anteflexion is often of importance.

When the original and determining cause of cervical alteration is to be found in small os or anteflexion, the efficient and permanent correction of these peculiarities is, of course, all essential. Mere dilatation is seldom or never sufficiently permanent, and a plastic operation on the os is always better. For narrow os one of the simplest procedures is an incision of the posterior lip of the cervix in the median vertical plane which, after the removal of a small wedge of cervical tissue to permit an easy approximation of the two mucous membranes, is sutured

in the horizontal plane (Fig. 14). Another excellent procedure is that described by Pozzi, in which a similar incision and suture is made at each side of the os laterally; at the conclusion of this operation the os presents the appearance of the bilateral laceration so common in multiparæ. It is unnecessary to add that in both these operations and especially in the Pozzi the incisions should be short and only sufficient to enlarge the os to a degree not much above the highest normal.



Fig. 14.—Diagram to illustrate a posterior discission of the cervix: *a*, The incision; *b*, the sutures; *c*, the final result; the tied sutures are within the slot and invisible.

The mechanical condition which exists in the partial arrest of development which is commonly known as ante-flexion of the cervix has been already described in Chapter V and illustrated in Fig. 9, p. 73. The plastic for its relief consists of a transverse incision in the anterior vaginal wall just above the cervix (Fig. 15). The incision should be about $1\frac{1}{2}$ inches in length, although this should vary somewhat according to the size of the vagina. It is carried first through the mucous membrane and then through the fascial plate which underlies the vaginal

wall, and which is the main factor in holding the cervix forward. As soon as this has been incised the loose areolar tissue beneath the peritoneum is reached, and it is then a very simple procedure to free the anterior surface of the cervix from all its anterior attachments

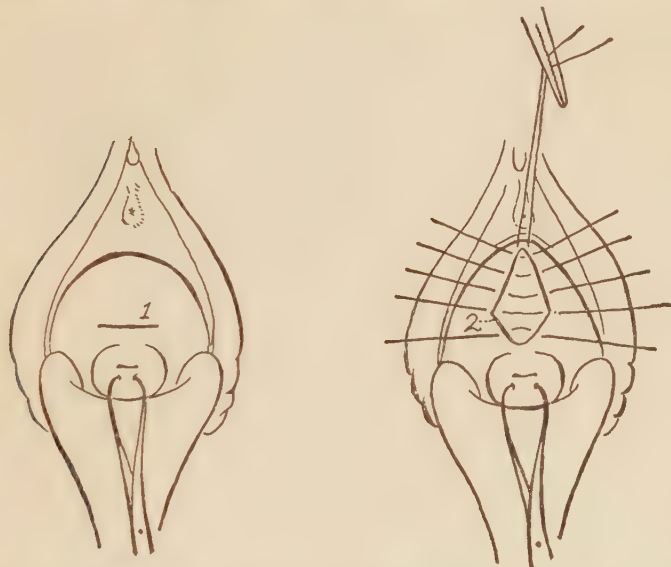


Fig. 15.—Diagram to illustrate an anterior release of the cervix: 1, The transverse incision; 2, the incision opened in an anteroposterior direction by traction with forceps, and the suture inserted. The anterior and posterior halves of the lozenge are, in fact, of equal size, but the posterior half is necessarily shown foreshortened; each half should, in fact, receive the same number of sutures.

to the level of the internal os by blunt dissection with the finger, but it is important to carry out this dissection laterally also, and somewhat beyond the width of the vaginal incision. There is usually very little bleeding, and what there is comes from the cut edges of the incision only and will be controlled by the suture. The

transverse wound is now closed vertically, usually by a running suture, thus lengthening the vaginal wall and the fascial plate, and throwing the cervix back into its normal position. The only point to be noticed in placing the suture is that it must throughout catch all the layers of the vaginal plate if the bleeding is to be controlled, and this is especially important about the angles of the original incision. If this point is neglected there is some risk of a hematoma behind the suture, but with a little care this accident should be avoided. In the majority of cases it is necessary to perform a discission of the os in combination with this plastic.

It is well known that some degree of cervical laceration occurs in most labors, and that in themselves these lacerations do not, as a rule, interfere with subsequent fertility. There are, however, some cases in which the secondary results of a laceration may cause sterility by the production of hostile secretions. For instance, eversion of a lacerated cervix favors infection of the cervical glands and consequent hostility, or cicatricial contraction about a laceration may distort the shape of the os or canal and cause retention and inspissation of the secretions. These cases must be operated upon, and in sterility cases it is especially important that the operation should be so devised as to remove all nabothians and to result in an ample os of normal shape, but the details necessary to this result are only those which are always given in the text-books.

Surgery of the uterus proper by the vaginal approach

is in sterility practically limited to curetage, but while from the frequency of alterations in the mucous membrane of the uterine cavity a routine exploration with the curet is desirable during operation, in most cases of sterility we feel very strongly that unnecessarily deep curetage may actually reduce fertility and should be avoided. At the beginning of this operation the curet should be made to cover the whole surface of the uterine cavity, but in the most gentle manner possible. If redundant mucous membrane is encountered it should be thoroughly removed, but not roughly or to an unnecessary depth. Overcomplete curetage of the uterus is very frequently followed by diminished menstruation, which is probably due to imperfect regeneration of the mucous membrane, such as may in itself interfere with proper nidation. Curetage of the uterine cavity should, therefore, be gentle in contradistinction to that of the cervical cavity, in which a fairly deep curetage is usually necessary, and, moreover, seems to be followed by no ill effects.

The conditions which indicate abdominal operating have been taken up in detail in preceding chapters, and need not be repeated in a chapter on technic. The methods of dealing during operation with actual new growths and other pathologic entities are modified by the existence of sterility, only in that it is here even more important than in other cases that all the normal tissues of the organs should be carefully preserved. Cases in which we have been obliged to operate after a previous

unsuccessful operation have, however, taught us a prevalent mistake in such unsuccessful operations. This is that they have usually been limited to the removal of an easily apparent, gross abnormality, such as a fibroid or an ovarian neoplasm, but have neglected the complicating or secondary conditions, which are often far more important to the sterility than the actual pathologic entity. When, however, such an operation for sterility has been preceded by an adequate examination, with a determination of the alterations of mechanism, and of the secondary pathologies which have occurred, this mistake is seldom made. The mere myomectomy, ovariectomy, or other operation will then be preceded by the necessary vaginal plastics, or accompanied by other conservative abdominal procedures, such as those which are next to be taken up. It will for this reason be likely to be followed by pregnancy, when without the additional work it would have been unsuccessful.

In the abdominal surgery of the uterus a question that comes up in every operation for sterility is as to the necessity of a suspension. When there has been a displacement or a prolapse the answer to this question is obvious, and some form of suspension must be chosen which will leave the uterus in its normal relationships. The actual method we believe to be unimportant; the operator should choose that one which experience has taught him yields the best results in his hands. When, however, the cervix lies in the axis of the vagina and fixed forward by a short anterior vaginal wall, suspen-

sion is never to be performed, even where otherwise indicated, as, for instance, in retroflexion, without at the same time releasing the cervix in the manner which was described above under the treatment of antelexion. If this is not done the suspension of a retroflexion will invariably lead to antelexion with possibly dysmenorrhea, poor drainage, and other bad consequences (Fig. 9, p. 73).

A suspension is also indicated in connection with any other abdominal operating, whenever there is any degree of sagging of the body of the uterus even without actual retroversion or prolapse. This condition sometimes occurs because of poor uterine supports and is also common in cases of subinvolution following childbirth. It is a frequent cause of pelvic congestion and should be corrected just as carefully as any retroversion. Suspension may also be advisable in sterilities in which there is no actual abnormality of position, but in which chronic congestion has been a marked feature. The forced elevation and forward position which follows any proper form of suspension is only temporary, but even a temporary change of level often aids materially by promoting a better emptying of the uterine veins.

It may also at times be a necessary part of the technic of elevation of the ovaries.

We come now to the surgery of the ovaries. This surgery we consider the most important single feature in the treatment of sterility of the female. It can be divided into two parts, viz., the surgery of pathologic

conditions and surgery where the trouble is more functional in its nature. It must be remembered, however, that even where the basic condition is pathologic the surgical indication is that the function of ovulation has been interfered with by consequent anatomic alterations in the ovaries (Chapter III, p. 56).

The chief *pathologic* lesions which are of importance in sterility are those benign cysts which can be safely removed without taking out the whole ovary. There are three common types—the simple thin walled cyst filled with clear fluid derived from an abnormal graafian follicle; the so-called blood cyst which comes from a degenerate corpus luteum, and the dermoid cysts. In any of these cases it is usually possible by careful dissection to remove the cyst entire and leave at least a major portion of the ovary. Where the cyst is large it will often seem that the ovary has been destroyed, but careful palpation around the base of the cyst will usually disclose the fact that there is ovarian tissue still present, although it may have been much thinned and drawn out upon the body of the cyst. An elliptic incision through the external layer 1 inch or $1\frac{1}{2}$ inches away from the base and extending around the circumference of the cyst at this level will expose the inner cyst wall. Careful blunt dissection will then enable the operator to remove the cyst without rupture, and he will usually be surprised to find how good an ovary will be left. The edges can then be trimmed away and the wound in the ovary sutured with silk.

In addition to these cases where the trouble is largely pathologic we find many cases where inspection shows evidence of deranged function. In these cases the ovary is enlarged, tense, and rather globular in shape. The surface is smooth and shiny and does not present the scarred appearance typical of the normally functioning ovary. When such an ovary is incised either one of two conditions may be found. The first is characterized by the presence of large numbers of tiny cysts 2 to 3 mm. in diameter with exceedingly thin walls and containing a drop or two of clear fluid (Fig. 7, p. 56). This condition is due to the fact that the graafian follicles, instead of maturing and discharging their ova month by month, as they should, have developed to a certain point and have then remained stationary with the death or absorption of the ovum and a thinning out of the normal membrana granulosa. Where this condition has gone on for some time the ovary gradually becomes filled with these retention cysts and is consequently larger and more tense than normal. The ovary then has gotten into a vicious cycle where, due to the tension within, no follicles can be matured beyond a certain point, and where, therefore, the function of ovulation ceases. We are accustomed to speak of an ovary where this has occurred as a "retention cyst ovary," reserving the term "cystic ovary" for those cases where one or many of the cysts have enlarged and become pathologic. The other condition which may be found as a cause of moderate enlargement of the ovary is the presence of corpora

lutea which have failed for some reason or other to retrograde as they should, and have persisted in a state of greater or less activity. This condition is known to occur in other mammals and is particularly troublesome in cows. The theory of the inhibitory action of the persistent corpus is that it acts more or less like the corpus of pregnancy, and while it does not prevent menstruation,¹ as the latter does, it often lessens it in amount and practically invariably interferes with normal ovulation.

There is one other condition not infrequently found in the ovary which must be dealt with, and that is a thickening of the external layer and a general sclerosis of the organ. The appropriate treatment of this latter condition is some form of decapsulation or scarification. When pronounced it is not a particularly hopeful condition as regards the prognosis of a sterility, since it is often associated with a premature development of menopausal changes, but in its more common lesser degrees it is usually susceptible of relief.

In order to operate upon the ovary delicately some method of fixation is necessary. This is probably best accomplished by placing clamps on the ovarian ligaments close to either pole of the ovary. It is important to remember that both blood- and nerve-supply enter the ovary along this ligament, and therefore the pressure

¹ We must recognize in the ovaries, as in the testicles (Chapters III and XIII), the existence of two distinct functions, and that in the ovaries also the function of the interstitial tissues (which here govern the estrous cycle and menstruation) is far less easily disturbed than the reproductive function which is the part of the epithelial cells, and in the ovaries comprises the production and release of the ova.

by the clamp should not be sufficiently great to traumatize the nerve-fibers or blood-vessels, and the clamps should not be allowed to remain too long a time in position. It is best to cover the jaws with rubber tubing in much the same way as is done with gastro-enterostomy clamps. After the ovary has been thus fixed the usual procedure in dealing with "retention cyst ovaries" is to split the organ partially but throughout its length. This gives an opportunity to see the character of the ovarian tissue and to see and remove whatever may be causing the enlargement. A number of the little cysts will be exposed or incised by this procedure, and it is easy to puncture those which are further out in the substance of the ovary by the gentle use of some blunt instrument. This does little harm to the ovarian tissue and may even have a certain amount of stimulative action.

Resistant corpora lutea of fairly normal character can be expressed from the ovary by gentle pressure with the fingers. Many persistent corpora are less normal in their constitution and have become adherent to the surrounding tissue. If any such corpus cannot be expressed by gentle pressure it should be incised and cleaned out by other methods. When in such cases there is much yellow luteal tissue which is adherent to the ovarian tissue, it should be considered to be derived from the corpus, and all such tissue should be removed. It is not infrequent to find beginning cystic degeneration of a persistent corpus. Such early cysts are usually filled with

blood or dark brownish material and, if not too old, contain remains of luteal tissue in their walls. They should, of course, also be removed as completely as possible.

After removing whatever cystic or other tissue seems necessary the ovary should be sutured. Fine silk is by all odds the best form of suture material, and the needle should be round pointed and as fine as can easily be manipulated. An excellent form of suture is the one illustrated in the diagram (Fig. 16), since this is designed

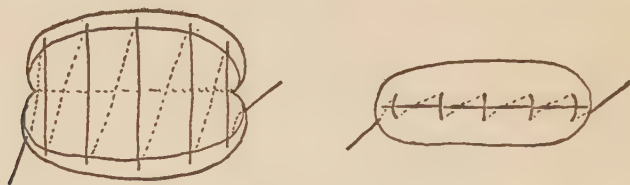


Fig. 16.—Suture of a bisected ovary. The buried portion of the suture runs diagonally, the external portion draws directly across the cut. This method yields a very accurate approximation. The bisection here shown is deeper than is ordinarily justifiable.

to close all dead spaces and to make as perfect as possible approximation of the edges.

Before closing the abdomen it is always important to see how the ovaries and tubes are going to lie in the pelvis when released. This is important for two reasons. The first is that in cases where the tubes or ovaries have been adherent they should not be allowed to return to the same position, since the adhesions are then certain to be re-formed. The second reason is that their position may often, if too low or abnormal in any other way, interfere with normal circulation, and result in congestion

in much the same way that congestion occurs in the male from varicocele. Often all that is necessary to bring about normal position, provided, of course, that anything at all must be done, is a simple suspension of the uterus. Occasionally, however, the ovarian ligaments are so long, or there is already so much tendency to varicosity in the veins of the broad ligament, that it is necessary to suspend the ovaries themselves. This we have been in the habit of doing by passing a single fine silk suture through the inner edge of the ovarian ligament near the inner pole of the ovary and through the peritoneum on the posterior surface of the uterus. It is important that this suture be so placed as to avoid any angulation of the tubes.

The necessity for care in the surgical handling of ovaries is well illustrated by some experiments which we have recently made on rabbits. We used throughout the experiments females whose previous fertility and breeding record were thoroughly normal. Four of them were used as controls. A laparotomy was performed on each of these and one ovary removed. A week after operation they were bred. Three of them immediately conceived and produced normal litters of the usual size. The other animal did not conceive for a month, but then everything went through as with the other controls. The remaining 7 animals were also operated upon, and in every case one ovary was removed, but, in addition, some procedure similar to that used in human ovarian surgery was carried out on the other ovary. In a number

of cases the only thing done was to tie off a small amount of the blood-supply, in others part of the ovary was removed in addition. These animals were bred in precisely the same way. Only one conceived immediately and the litter consisted of less than half the normal number. In no other case did conception occur at all until two or three months had elapsed, 3 then became pregnant, and when their ovaries did thus resume activity it seemed to be complete and normal. The 3 other individuals remained completely sterile. When these "sterile" rabbits were examined postmortem certain changes were found to have occurred in the remaining ovary. These have not as yet been fully studied microscopically, and therefore it is too early to make any definite statement, but from gross appearances it would seem that some "retention cyst" condition had been produced. No conclusion can, of course, be drawn from such a small number of experiments, but it does seem evident that any operative procedure upon the ovary may inhibit function for a time, and that if this procedure is more drastic, as it was in the case of the 3 sterile animals, ovarian function may not recover at all. The lesson of this is obviously that the least possible force should be used in manipulation of the ovaries, and that the greatest care should be taken to avoid the removal of any large amount of ovarian tissue.

We turn now to a consideration of the surgery of the remaining part of the genital tract, viz., that of the fallopian tubes. This part of our discussion has been

designedly left for the last, since up to the present time it has always been one of the most discouraging fields in the surgical treatment of sterility, and because of the fact that the recent development of transuterine insufflation of the tubes has completely revolutionized our methods in its diagnosis and treatment.

Since this method of diagnosis and treatment is a recent one and still, at least for the majority of the profession, *sub judice*, a somewhat detailed discussion of the technic, of the dangers involved and of the advantages, may not be out of place at this point.

The test was first devised and brought to practical usefulness by Rubin,¹ of New York, in 1920. The general principle of his technic remains largely the same, although he has modified it in a number of minor particulars, such as, for instance, the substitution of carbon dioxid gas which is more rapidly absorbed than oxygen, the gas which he first employed. The method is to allow the gas to escape from a high-pressure tank through some form of pressure-reducing valve and through some apparatus by which the volume of the gas passing in a given time may be more or less accurately measured. This apparatus with the gas passing at a known rate is then connected up with an intra-uterine cannula. Attached to the tube is a side arm with a gage capable of measuring the pressure of the gas within the tube in millimeters of mercury. The cannula is passed through a urethral tip so that when the whole is introduced into

¹ Rubin, I. C., Jour. Amer. Med. Assoc., 1920, lxxiv, 1024; lxxv, 661.

the uterus the tip will form a gas-tight joint at the cervix. After the cannula is in place the gas is turned on, and, if there is no obstruction, after a *preliminary rise of pressure* the gas passes into the abdominal cavity through the tubes. This fact is evidenced by the falling of the pressure shown in the gage and the fact that the gas is passing steadily as shown by the volume indicator (and in the absence of leakage). There are several other indications that the gas has passed, the usual one being subjective, and reported by the patient as a sense of pressure in the shoulders when the upright position is assumed; the other indication is furnished by auscultation of the abdomen, since in most cases it is possible to hear the actual bubbling sound made by the gas as it passes through the tubes. These indications are important, but an absolute proof of the passage of the gas is obtained by taking an *x-ray* plate of the upper abdomen with the patient in the upright position. A bubble of gas can then be seen pressing against the diaphragm. It is usually possible to determine the presence of this bubble of gas by the use of the fluoroscope when large amounts have been injected, but the *x-ray* plate is the only reliable guide where the amount of gas has been small. Dr. Rubin's original articles and others by Peterson,¹ of Ann Arbor, state that it is necessary to inject between 200 and 300 c.c., in order to get positive findings by *x-ray* or fluoroscope. This amount practi-

¹ Peterson, Reuben, Surg., Gynec., and Obst., August, 1921, vol. xxxiii, p. 154.

cally always causes the patient to feel a severe pressure on the diaphragm when the upright position is assumed. It may cause quite severe discomfort for a good many hours afterward even with carbon dioxide.

At the time when we were using this technic we saw somewhat more threatening symptoms in several cases. We well remember one patient in whom after an injection of about 250 c.c. the pulse suddenly dropped to 40, and there were other symptoms pointing to a severe and an alarming stimulation of the vagus. Luckily the effect only lasted a relatively short time.

Such in a very general way is the usual technic. There is no question that insufflation by this method is a most valuable procedure in the diagnosis and treatment of tubal disease, but whether this is the best method and whether insufflation by any method should be used as a routine measure are questions which are certainly still open to consideration. Dr. Rubin justly warns against insufflation in certain conditions, notably where there is pus or blood in the cervix or uterus which might be blown into the tubes, or where there is any acute inflammatory condition in the pelvis, and now that the first enthusiasm for the test has had a chance to cool down it has seemed to us extremely important to consider its dangers and advantages from every point of view, and, if possible, to avoid the former and gain the latter.

What then are the dangers? In the first place, is there any danger to life? With the test as outlined this can be answered frankly in the negative. It has

been performed thousands of times by many different operators without there having been, so far as we are aware, a single death; the risk to life may be, therefore, dismissed as practically non-existent. One possible danger from the sudden pressure of a large amount of gas in its effect upon the heart has been mentioned. This can be avoided by using small amounts and by being careful to have the patient assume the erect position slowly.

The possible risk of morbidity must also be considered. The chief danger to health even in properly selected cases, and where there is no evidence of active inflammation, comes from the likelihood of stirring up old trouble of an inflammatory nature. That this danger is not a mythical one is, we think, plainly shown in the following brief case histories:

The first patient gave a history of peritonitis at the age of eight, and on examination showed a uterus drawn over to the left side with what seemed to be an enlarged adherent ovary; 50 c.c. of gas were injected fairly readily through the tubes, but beyond symptoms of general abdominal discomfort there was no evidence of pressure on the diaphragm. The patient evidently had intestinal adhesions, since for some time after our examination she suffered from symptoms which could only have been caused by a general stirring up of the old process.

The second case had also had a pelvic peritonitis from an appendix some two years before she was seen, an inflammation which had apparently involved the

tubes, since the gas failed to pass. In this patient the attempted injection of even a small amount of gas at a pressure not exceeding 100 mm. of mercury stirred up the old trouble for a short time. If higher pressures had been reached it is not at all unlikely that a new attack might have developed with more serious consequences.

The third case illustrates this last point. The patient had been under our care for some months and had had gas successfully injected and passed through the tube by a technic which is to be described later, at a low pressure and without pain. While away in another city she consulted a surgeon who attempted to inject the gas by the Rubin technic, but who was unable to make any pass even at a pressure which was high enough to cause extreme pain. When seen some two weeks later this patient presented a large mass behind the uterus, and at operation a short time afterward it was found that an old quiescent tube with closed fimbriated opening had been so traumatized by this method that an acute hydrosalpinx the size of an orange had developed. A normal tube on the other side explained the fact that gas had at one time passed. The affected tube was removed and the patient is now, about a year and a half after the operation, in the ninth month of a normal pregnancy. This case illustrates at once the greater efficiency of the low-pressure technic and the greater danger which is inherent in the high-pressure method. It incidentally also calls attention to one of the limitations of the test by whatever technic it is performed, which is that the pass-

age of gas does not prove that both tubes are patent, nor furnish any evidence that one tube only is closed.

The lesson to be drawn from this discussion of the dangers and from these case histories is obviously that the cases must be chosen with even more extreme care than was originally postulated by Rubin. It does not mean that the insufflation test should never be used. It means for us that it should not be used as a routine measure in cases in which the other signs and symptoms point to tubal trouble, and in which either for reasons of health or by the patients' decision after all the circumstances have been explained to them, an operation is to be performed in any case. We believe, on the other hand, that it should be used in cases in which the decision about operation is to be determined by the condition of the tubes whether present or open, and in otherwise suitable cases in which for any reason information which cannot be obtained in other ways is essential to an opinion about the case. If it is used in cases in which there is any doubt about its applicability the patients should certainly be warned of the risk, slight though it be, of stirring up latent trouble, and should be cautioned to spend the next day or two either in or on the bed.

If we feel then that the test is of somewhat limited value in diagnosis we have come to feel that it has a correspondingly larger and more useful rôle in therapeutics. Peterson¹ has recently read a paper telling

¹ Peterson, Reuben, and Cron, Roland S., *Jour. Amer. Med. Assoc.*, September, 1923, lxxxi, 980.

of successful pregnancies following this procedure when it has been used as the only method employed. These successes were rather accidental than designed; such results can only happen where the tubes are essentially normal, and with further knowledge they may furnish an indication for the use of this method, but this can hardly be claimed at present. There is, however, one other therapeutic use of insufflation which we are now using and which we believe should be tested further. In a few cases in which at operation the tubes have been found to be closed at the fimbriated extremity, but otherwise apparently normal, we have endeavored to preserve the patency secured at operation by subsequent insufflation, using in these cases rather more pressure than we personally consider safe in cases in which the condition of the tubes has not been actually seen. We have not yet had a sufficient number of cases to make a final decision or report, but one such case history may be worth mentioning:

This patient was operated on in May, 1921. The right tube and ovary had been thoroughly destroyed by inflammation from an old attack of appendicitis, and the tube on the other side had also been closed. The right tube and ovary were removed and a plastic done on the left tube, making a new opening. At the time of this operation we had not yet begun the use of insufflation, but in the following October we did use it to test the operative patency. This test was made while we were using a high-pressure technic and ended in failure,

though the pressure was run up to over 200 mm. A second attempt ended in the same way. A third attempt was doubtful and it was not until the fourth attempt that gas passed. This finding was confirmed by *x-ray*. Twice more the injections were made, once in February, 1922 and again in September of that year. Following this last insufflation a pregnancy occurred within a very short time, and the patient was delivered of a normal baby on July 12, 1923.¹

From the preceding discussion it has become plain that we are dealing with a most important test and with a therapeutic measure of possibly great importance also; a procedure which marks a definite advance in the diagnosis and treatment of sterility. That it perhaps is not without its dangers has also been pointed out. Is there not some way by which these dangers can be minimized and the benefits retained? With this object in mind we have attempted to modify the technic. Our procedure is as follows: The gas is first allowed to expand and become warmed in an ordinary gas-anesthesia rubber bag (Fig. 17). This warming of the gas we consider essential since the introduction of cold gas into the uterus immediately sets up a spasm of the musculature, and thus at least temporarily prevents passage of the gas through the tubes. The gas is then drawn into a 50-c.c. all glass syringe through a three-way cock which is then turned so that the gas can be injected through the cannula. Attached to this part of the circuit on a

¹ She is now believed to be pregnant again.

side arm is the gage of a blood-pressure machine, and toward the end of the rubber tube is a glass bulb containing cotton or gauze to filter the gas. Any intra-uterine cannula which can be bent to a suitable angle for the individual case may be used. We have found that the following is a very useful device—it is made by having an instrument maker solder a 4-inch hollow metal

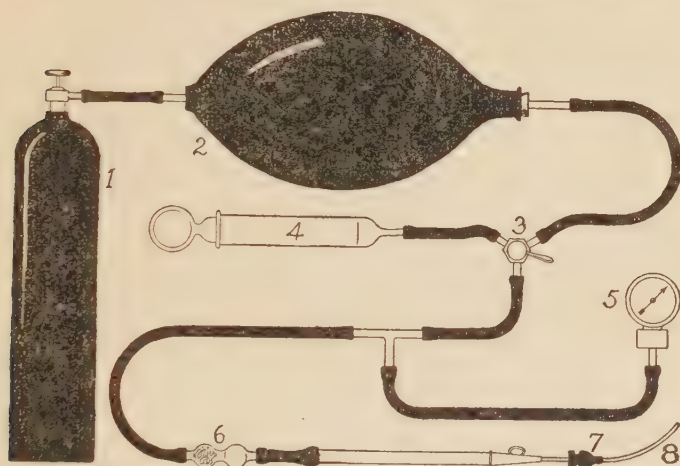


Fig. 17.—Dr. Macomber's insufflation apparatus: 1, The gas tank; 2, the rubber bag; 3, three-way cock; 4, glass syringe; 5, gage; 6, filter; 7, sliding rubber acorn tip; 8, catheter.

tube to a silver eustachian catheter. It is a good plan to have one or two extra holes bored near the tip. A simple urethral tip is used to render the cervix gas-tight.

We have found that the most important single thing to remember in using this apparatus is to be sure that no force is employed at any time, and that every maneuver is conducted with the most extreme gentleness. After the gas has been warmed in the bag several syringe-

fuls are withdrawn and expelled through the cannula, thus filling the whole system of tubes with carbon dioxide. The sterilized cannula, which has been bent to the shape desired for the individual case, is next introduced through the internal os, and the rubber tip is forced firmly into the external os. It is advisable to catch the cervix with bullet forceps so that traction may be made against the inward pressure of the cannula. An assistant listens with the stethoscope over the lower abdomen, then with gentle pressure the injection is begun. In normal cases, with these precautions, gas can be heard to pass and can be felt to pass by the operator's hand upon the syringe, at pressures which do not exceed 40 mm. of mercury. The initial increase of pressure up to 75 or 100 observed by Rubin seems to be due entirely to a spasm of the uterine muscles, which is not necessary and which may cause a good deal of discomfort to the patient; they rarely feel any sensation before the pressure is raised to 60 mm. In a few cases it is, of course, necessary to use higher pressures even for diagnosis, but we believe that these higher pressures can be used far more safely if under direct control of the surgeon's hand, and capable of being instantaneously released if need should arise. There is another point which we believe to be important, and that is that all the necessary information can be obtained by the use of a very few cubic centimeters, and that it is unnecessary and unwise to inject large amounts in order that *x-ray* pictures may be taken. Done in this way and on suitable cases the test is ap-

parently absolutely safe and does not cause discomfort to the patient. It is surprising how few the failures to pass gas at the first attempt become as compared with those encountered with the original technic.

Furthermore, it must always be remembered in the evaluation of a test of this kind that no conclusions drawn from it can ever be absolute, but that its results must always be taken into consideration with all the other findings in the case. It is perhaps true that the only absolute proof that the gas has passed comes from a skiagraphic or fluoroscopic confirmation, but when the gas is heard to bubble through the tubes and the syringe is felt to empty under a moderate pressure without the escape of gas around the cervical plug, the assumption that gas has passed would certainly seem to be warranted. Moreover, in the now considerable number of cases in which we have submitted the results obtained by this method to the test of operation we have so far met with no mistaken conclusions.

The actual operative technic involved in the opening of closed tubes is about as delicate a bit of surgery as can be found anywhere. The greatest care should be taken not to traumatize tissues. The circulation must be preserved at any cost and the operation so performed that all diseased tissue is removed. Where the only trouble is closure of the fimbriated ends it is sometimes possible by extremely delicate dissection to reopen the natural ostium. If this can be accomplished it is often found that a single fine silk suture can be so placed as to prevent

the rolling in again of the raw surface. If then the bleeding points are tied off with very small ties of the finest silk and care is taken to leave the tube in a normal position, success may be looked for, provided the tubes can be kept open by the injection, at later dates, of carbon dioxid. Where there is actual destruction of tubal tissue with the formation of clubbed tubes, or a small hydrosalpinx, the operator should first remove everything down to the normal portion of the tube. The tube is then split back for about $\frac{1}{2}$ inch and the mucous membrane so sutured to the peritoneum as to be somewhat everted. The suture should always be of the very finest silk, and only fine, round-pointed needles should be used. In all such cases it is, of course, essential to test the patency of the rest of the tube by some method as soon as the new opening in the tube has been made, or after the normal ostium has been reopened. We have been in the habit of doing this by injecting sterile salt solution with a blunt-pointed glass syringe through the tube into the uterus. This method has proved to be perfectly satisfactory. In the rather rare cases where the obstruction is in the isthmus, or intramuscular portion of the tube, this method of injecting saline solution may be useful therapeutically, since it is practically impossible to do any operative procedure there which will not leave things worse off than at the start. After operation it is, as we have said, essential to keep the tubes open, and the carbon dioxid test certainly offers the best means at our disposal. Insufflations should probably not be begun before the

end of the third week. If the tubes are found patent at that time the injection should be repeated two or three times at intervals of a few months to make certain that adhesions do not re-form.

In concluding this presentation of the rôle which surgery plays in the treatment of female sterility we wish to emphasize a few of the main points which to us seem of the greatest importance. First, a thorough knowledge of the physiology is imperative to both diagnosis and treatment, and, second, before any surgery is attempted each case must be so carefully studied that all deviations from the normal are recognized. When this has been done, and only then, can surgery, no matter how skilful, be of any value in restoring altered function. The actual methods adopted may, of course, vary somewhat in the hands of individual operators, but in the very nature of the case they must be specialized methods; methods designed to follow physiologic rather than pathologic lines. Even where definite pathologic lesions are present the chief aim of the operator must be to restore rather than to remove, and the secondary disturbances which are always the direct cause of sterility must be attended to in every case. This is quite as important to fertility as the removal of the determining cause.

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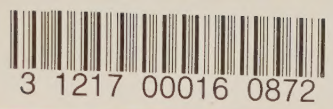
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